VIBRATION TEST EQUIPMENT

OPERATING AND SERVICING INSTRUCTIONS

MODEL TF11

TRACKING FILTER

SERIAL NUMBER 396

UNHOLTZ-DICKIE CORPORATION

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UNHOLTZ-DICKIE CORPORATION
6 BROOKSIDE DRIVE
BARNES INDUSTRIAL PARK NORTH
WALLINGFORD, CONN. 06492

203 265-3929

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1. GENERAL DESCRIPTION AND INTRODUCTION

Any vibration test that requires filtering of one acceleration channel, should have filtering available on all channels. The TF11 has been designed as a compact economical instrument to provide the same performance at one-half the price and one-sixth the panel space of competitive units.

The TF11 is a unity gain Tracking Filter with continuous variable constant 10% bandwidth. The upper and lower bandwidth limits are adjustable. A fixed bandwidth from 2 Hz to 200 Hz can be selected. Fig. 1.1 shows the front of the TF11, and a block diagram of a typical test setup is shown in Fig. 1.2. Oscillators other than the U-D Model OSC-1 may require certain precautions listed in Section 4.6.

Interchangeable mounting with Model D22 Charge Amplifiers allows the TF11 to be mounted next to the corresponding Amplifier in a multichannel system.

Utilizing the low distortion output from the OSC-1 Sweep Sine Generator, the TF11 has no unnecessary duplication of circuitry. Co-Quad circuitry eliminates the possibility of "loss of lock" at high sweep rates or low input levels.

The OVERLOAD detector on input is connected to system interlock to prevent run away of system. The RANGE, BANDWIDTH and BYPASS switches are also connected to the interlock.

In the BYPASS mode, the rear filter OUTPUT is connected directly to the INPUT and the interlocks are bypassed to allow the TF11 to be used as a monitor. The front panel OUTPUT remains connected to the filtered unity gain output.

NOTICE: For operation with Tuning generators other than OSC-1 after SN 155 see Section 4.6 of this manual.

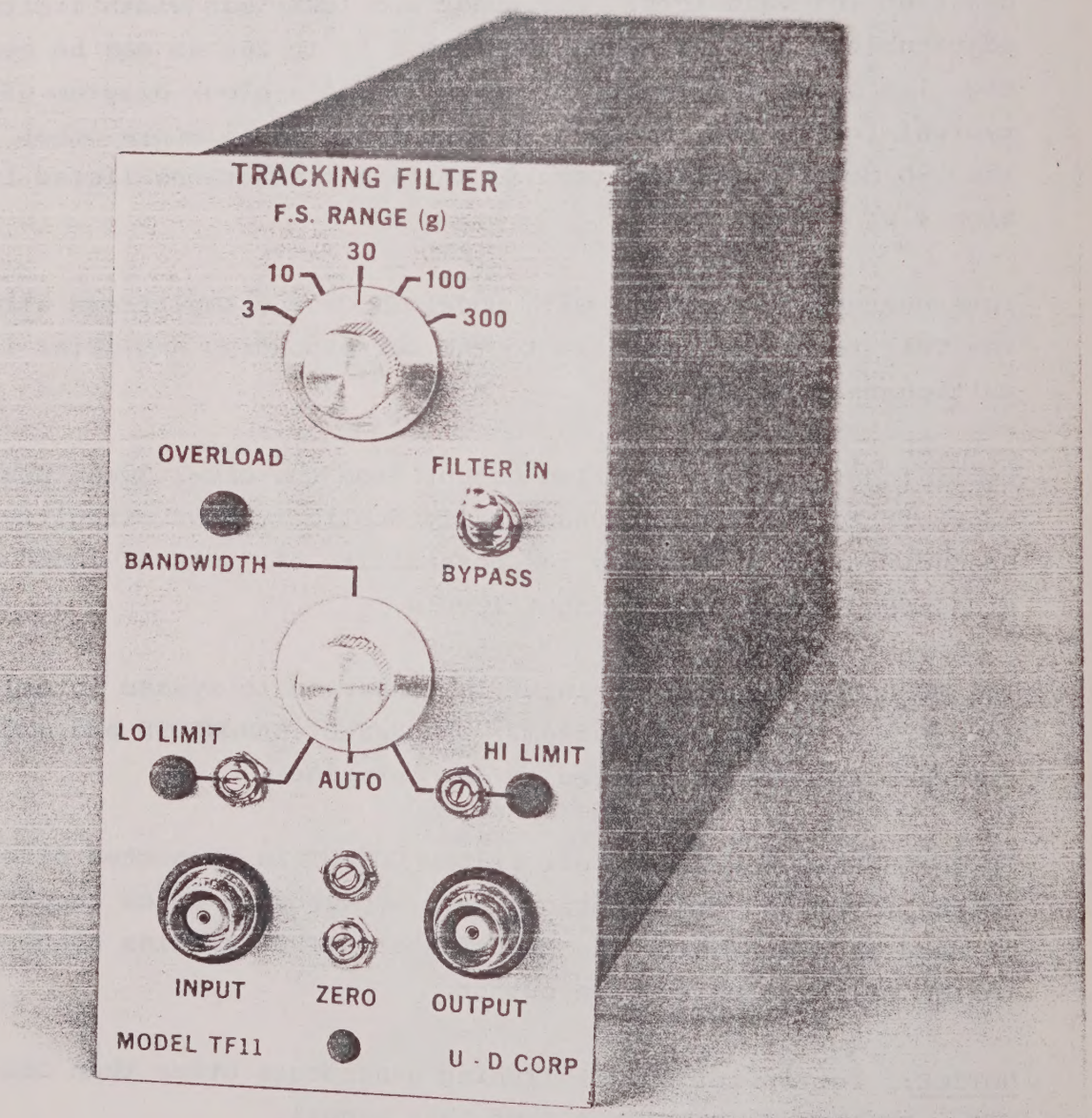
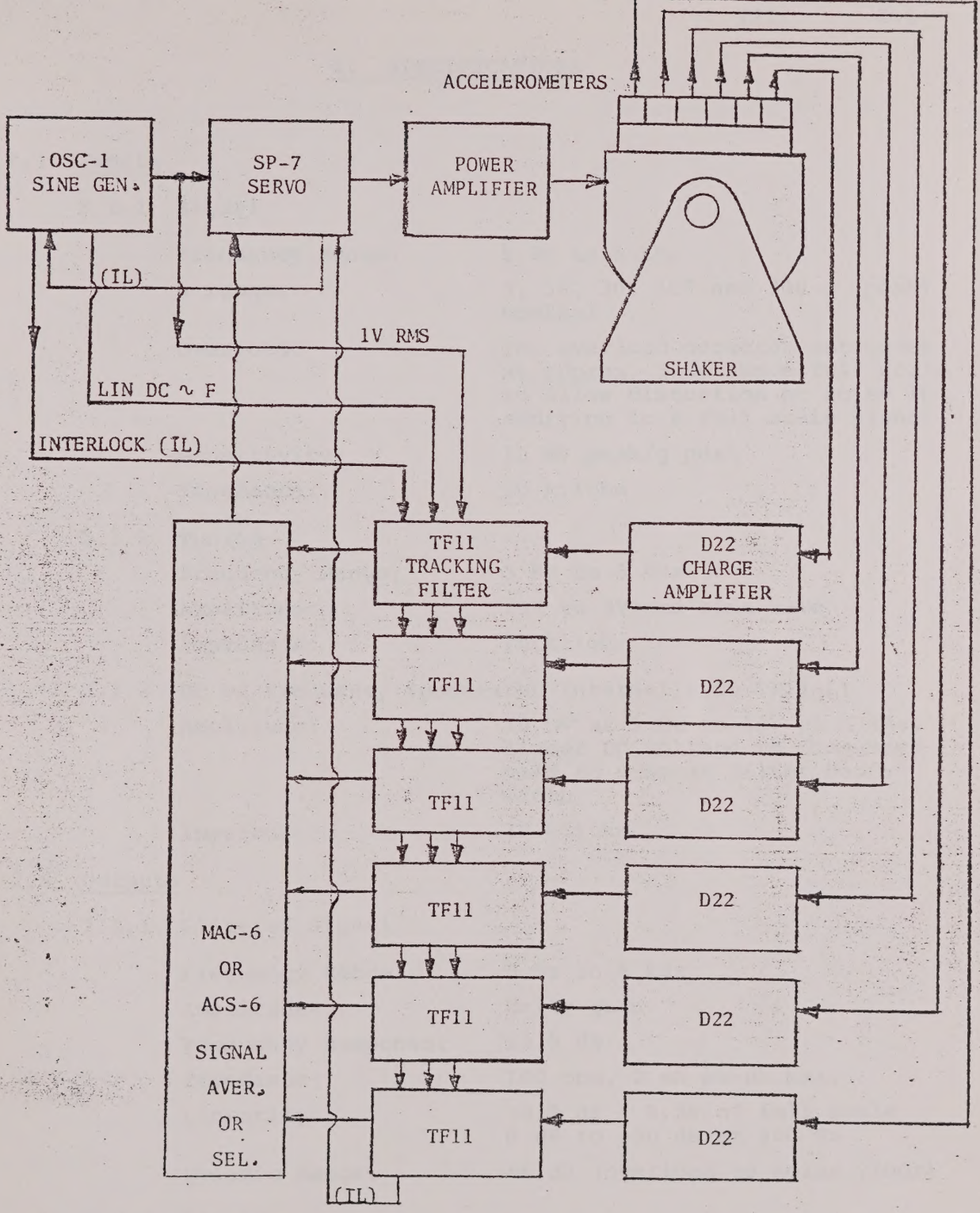


Fig. 1-1
Front View of TF11



TYPICAL TEST SETUP WITH TF11

FIG. 1.2

2. SPECIFICATIONS

2.1 Inputs

2.1.1 Signal

Frequency Range:	5 Hz to 5 kHz
g ranges:	3, 10, 30, 100 and 300 g (peak) nominal
Overload:	The overload detector activates at approx. 3 dB above full scale to allow distortion or noise in addition to a full scale signal
Sensitivity:	10 mV peak/g peak
Impedance:	20 kilohm

2.1.2 Tuning

Frequency Range:	5 Hz to 5 kHz
Amplitude:	.3V to 3V rms sine wave
Impedance:	20 kilohm

2.1.3 DC vs Frequency (generated internally on TF11-L)

Amplitude:	10 mV at 5 Hz to 10V at 5 kHz, linear DC voltage vs frequency used to program filter bandwidth
Impedance:	10 kilohm

2.2 Outputs

2.2.1 Filtered Signal

Frequency Range:	5 Hz to 5 kHz
Amplitude:	Unity gain
Frequency Response:	±0.5 dB
Impedance:	100 ohm, 2 mA pk-pk max.
Linearity:	±0.5 dB + 0.3% of full scale 0 dB to -50 dB at 400 Hz
Dynamic Range:	66 dB (overload to noise floor)

2.2.2 Log DC

Amplitude:	50 mV/dB, 0V at F.S. (-2.50 V at -50 dB)

	Conformity:	±0.25 dB, 0 to -40 dB, ±1 dB, to -50 dB
	Impedance:	50 Ω

2.3 Selectivity

2.3.1	Bandwidth:	10% of tuning frequency between limits
2.3.2	Bandwidth Limits:	Lower limit 2 Hz - 20 Hz Upper limit 20 Hz - 200 Hz
2.3.3	Filter Response:	Minimum 50 dB rejection at ±8 times ½ bandwidth points (Approx. 3 pole Butterworth)

2.4 Indicators

2.4.1	Overload:	Indicates overload of input
2.4.2	Lo Limit:	Indicates BW is fixed at lower limit
2.4.3	Hi Limit:	Indicates BW is fixed at high limit

2.5 Interlocks: Interlocks are provided to place the vibration equipment in STANDBY (no vibration) when:

2.5.1 The RANGE control is switched

2.5.2 The BANDWIDTH control is switched

2.5.3 The OVERLOAD detector is triggered

2.5.4 The FILTER IN BY-PASS control is switched (in BY-PASS all interlocks are by-passed)

2.6 Connections: All connections are at the rear of the chassis. A second INPUT connector and an OUTPUT connector from the filtered unity/gain output are provided on the front panel for monitoring purposes.

2.6.1	Inputs and Outputs:	BNC connectors are provided for SIGNAL IN, SIGNAL OUT, LIN DC v Frequency IN, LOG. DC proportional to filtered Output, TUNING IN.
2.6.2	Aux. Control:	A 25 pin "D" series connector is used for interlocks and to parallel patch tuning inputs and DC input between parallel channels

2.7 Signal Ground: A switch on the rear panel selects the signal ground to be connected to the AC line ground or to be floating (grounded through signal inputs and outputs).

2.8 Power: 105-125/210-250 V AC, 50-60 Hz, approximately 10 watts

2.9 Weight: 6 pounds

2.10 Size: 5.25 H x 2.8" W x 18" D. Uses Model 22RA Rack Adapter for six channel.

3. DESCRIPTION OF CONTROLS AND CONNECTORS

3.1 Front Panel (See Fig. 1.1)

3.1.1 F.S. RANGE - This 5 position switch selects the optimum operating range of 3.16, 10, 31.6, 100 or 316 g peak (10 mV/g). Each range has an approximate 3 dB over range before the OVERLOAD activates the interlock to allow for some distortion and/or noise signal in addition to a full scale input sine signal.

3.1.2 OVERLOAD Indicator - This LED indicator flashes when peaks of the input signal exceed full scale plus approximate 3 dB of the selected F.S. RANGE.

3.1.3 FILTER IN/BYPASS - In the FILTER IN position the signal OUTPUT on the rear of the TF11 is connected to the unity gain filtered signal. In the BYPASS position the signal OUTPUT is connected to the signal INPUT; the TF11 is deactivated in the BYPASS mode.

3.1.4 BANDWIDTH Mode Selector - A 3-position switch which selects the mode in which the bandwidth changes with change of the tuning frequency.

LO LIMIT - The bandwidth is fixed 2-20 Hz as selected by the LO LIMIT control.

AUTO - The bandwidth changes automatically as the tuning frequency changes between the limit selected by the LO LIMIT and HI LIMIT controls.

HI LIMIT - The bandwidth is fixed 20 - 2000 Hz as selected by the HI LIMIT control.

3.1.5 LO LIMIT Indicator - Lights when the BW is fixed at the LO LIMIT.

3.1.6 LO LIMIT Selector - This screw driver adjustment selects the LO LIMIT Bandwidth 2-20 Hz.

3.1.7 HI LIMIT Selector - This screw driver adjustment selects the HI LIMIT Bandwidth 20-200 Hz.

3.1.8 HI LIMIT Indicator - Indicates when the BW is fixed at the HI LIMIT

3.1.9 INPUT - This connector is in parallel with the rear INPUT and is intended for monitoring purpose.

3.1.10 ZERO - These screw driver adjustments are made easily accessible for the operator to adjust for optimum dynamic range.

3.1.11 OUTPUT - This connector makes the filtered unity gain accessible for monitoring purposes regardless of the position of the FILTER IN/BYPASS selector.

3.2 Rear Panel (See Fig. 3.1)

3.2.1 POWER - 3-prong connector for AC power input mates socket in U-D Model 11RA Rack Adapter.

Pin 1 (bottom) AC ground
Pin 2 (center) AC common
Pin 3 (top) 115 V/230 V AC 50/60 Hz

3.2.2 FUSE - GMW-1/2

3.2.3 EXT GND/INT GND Selector - Connects signal common of TF11 to Power Ground (INT) or isolates it (EXT)

3.2.4 AUX. CONTROL - A 25 pin rear panel connector provides for auxiliary system interconnections as described in thefollowing list. (See Table 3.1 for Pin Function)

3.2.5 INPUT - Unfiltered Signal Input

3.2.6 OUTPUT - Signal Output is connected either to unfiltered Signal Input (BYPASS) or to unity gain filtered output (FILTER IN).

3.2.7 TUNING - Input for reference AC signal OSC-1; used to tune the TF11. (.3V - 3V rms)

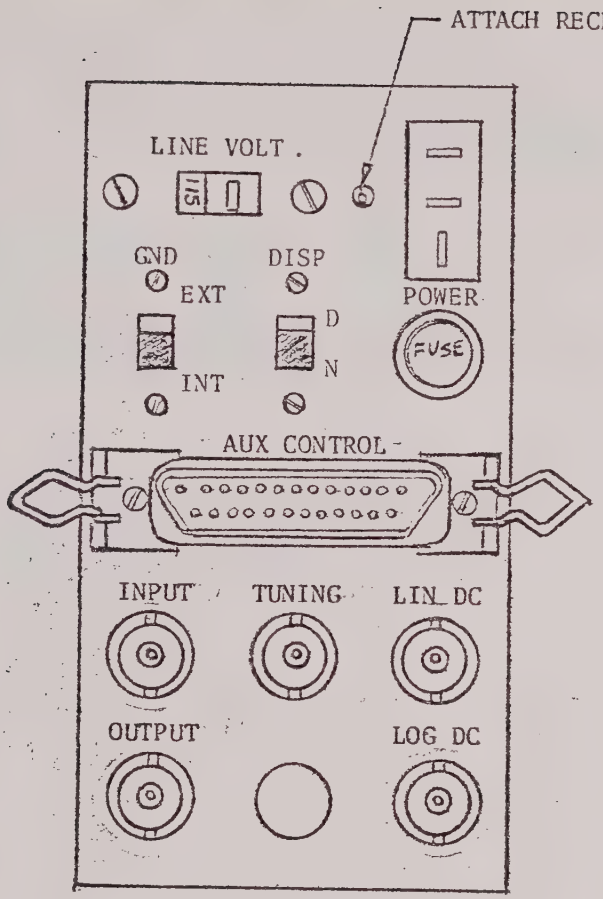
3.2.8 LIN DC - Input for 10 mV to 10 V DC (2 mV/Hz) signal from OSC-1; used to adjust to bandwidth of the TF11 in the AUTO BW mode. On TF11-L this signal is generated internally and available on LIN DC connector for interconnection to other TF11's without "-L" option.

3.2.9 LOG DC - Output for DC signal proportional to the log of the full scale filtered AC; may be used to plot the filtered signal on an X-Y Plotter.

3.2.10 DISPLACEMENT Mode Switch

D Position: DISPLACEMENT MODE

N Position: NORMAL



REAR VIEW TF11

FIG. 3.1

TABLE 3.1

AUX. CONTROL PIN FUNCTION

PIN NO.	FUNCTION
1 & 14	TUNING - Reference AC Input, from OSC-1 Sweep Sine Generator tunes the filter. This connection is in parallel with TUNING BNC connecter and may be used to patch tuning signal between TF11's in a multi-channel system (0.3 to 3V rms.)
2 & 15	LIN DC - 10 mV to 10 V DC Input signal, proportional to frequency (2mV/Hz) adjusts Bandwidth of TF11 in AUTO BW mode. This connection is in parallel with LIN DC BNC connector and may be used to patch the LIN DC signal between TF11's in a multi-channel system (see Fig. 4.1). On the TF11-L this is an output signal.
3 & 16	SINE - normalized reference AC Sine signal. May be used to slave a TF11 without A-TF11 Board. (5V rms)
4 & 17	COSINE - Normalized reference AC cosine signal; may be used to slave a TF11 without A-TF11 Board. (5V rms)
5	BW CONTROL - 40 mV-4V DC proportional to Bandwidth; may be used to slave limit controls in a multichannel system.
12 & 13	COMMON for LIN DC and TUNING signals, 50Ω to internal SIGNAL GND.
24 & 25	INTERLOCK - Used as an external series interlock connection, usually connected in series with the internal interlock series or a vibration excitor control servo (SP-7). The connection between 24 and 25 is NC and opens momentary when either of the RANGE or BANDWIDTH or FILTER IN/BYPASS controls is changed. Also, the connection is momentarily interrupted when the OVERLOAD detector is triggered. In BYPASS the interlock is held closed.

3.2.10 (cont'd)

In the DISPLACEMENT Mode the TF11 goes automatically into BYPASS when the BANDWIDTH switch is in AUTO and the LO LIMIT light is on and the RANGE switch is in 30, 100, or 300 g. (See also Section 4.8)

Notice that the front OUTPUT is always connected to the filtered signal.

3.2.11 LINE VOLT. - This screwdriver actuated switch is used to select operation with either 115 V or 230 V AC line voltage.

4. OPERATION

This section describes the operation of the TF11 in typical systems. If the TF11 is purchased as part of a large system, refer to the systems manual for specific installation, calibration and operating instructions.

4.1 Operational Checkout Procedure

Sections 6.1 through 6.3 can be used as a quick initial checkout procedure.

4.2 System Interconnection for Multiple TF11's

Fig. 1.2 shows a typical system using several channels of Tracking Filters. Fig. 4.1 shows the interconnection of the control signals (TUNING SIGNAL, LIN DC vs FREQ., INTERLOCK). All interconnections between TF11's are made through the AUX CONTROL connector.

The TUNING signal and the LIN DC v. FREQ. signal can be connected to any of the interconnected TF-11's.

4.3 System Grounds (Line Frequency Interference)

4.3.1 INT - EXT GROUND - As most instruments manufactured by Unholtz-Dickie Corp. the TF11 has isolated signal common, which can be connected to the Power Ground by a switch at the rear panel. In a system usually only one instrument is grounded INTERNAL all other EXTERNAL (through the shields of the interconnecting cables). Which instrument should be grounded is usually determined by trial.

4.3.2 Differential Input - In cases of extreme interference, the TF11 may be operated with differential input; to do so remove shorting strap between the commons of INPUT and OUTPUT connector at the rear of the instrument. (See Fig. 8.1)

Notice that any signal conditioner connected to the differential TF11 has to be grounded INTERNAL unless grounded through the accelerometer or other devices.

4.4 Output Zero

Before using the TF11, the output may have to be re-adjusted for Zero feedthrough of the tuning signal. Although the instrument usually settles within several minutes after power is turned on it is advisable to allow 15 minutes warmup for operation over the full dynamic range.

4.5 Adjustment of Bandwidth Limits

The limits of the constant percentage (10%) bandwidth range may be adjusted by using the LO LIMIT and HI LIMIT screw-driver adjustments. To set limits, set bandwidth switch to AUTO and select on SINE GENERATOR a frequency of 10 times the desired bandwidth limit. Adjust screw driver adjustment until LIMIT indicator just lights.

Notice: An ideal bandpass cannot be operated at a center frequency below½ of the bandwidth. Typically in a 3-pole pair tracking filter such as the TF11 an output error in excess of .5 dB is observed at tuning frequencies less than .65 X BW.

4.6 Sine Generators Other Than OSC-1 After SN 155

The TF11 Tracking Filter is designed to be used with the OSC-1 Sine Generator on range 5 Hz to 5 kHz. When used otherwise the following precautions must be considered.

4.6.1 OSC-1 Before SN 156 on RANGE 2 Hz - 2 kHz - The LIN DC output on any RANGE is 10 mV - 10 V; therefore on RANGE 2 kHz the AUTO bandwidth will be 25% instead of 10% and the frequency range of the LO LIMIT and HI LIMIT controls will be 8 Hz to 80 Hz and 80 Hz to 800 Hz. On OSC-1's after SN 155 the LIN DC on any RANGE is 2 mV/Hz to insure proper operation.

Solution: Use on RANGE 5 kHz only or consult factory FOR MODIFICATION OF LIN DC output (or use TF011-L).

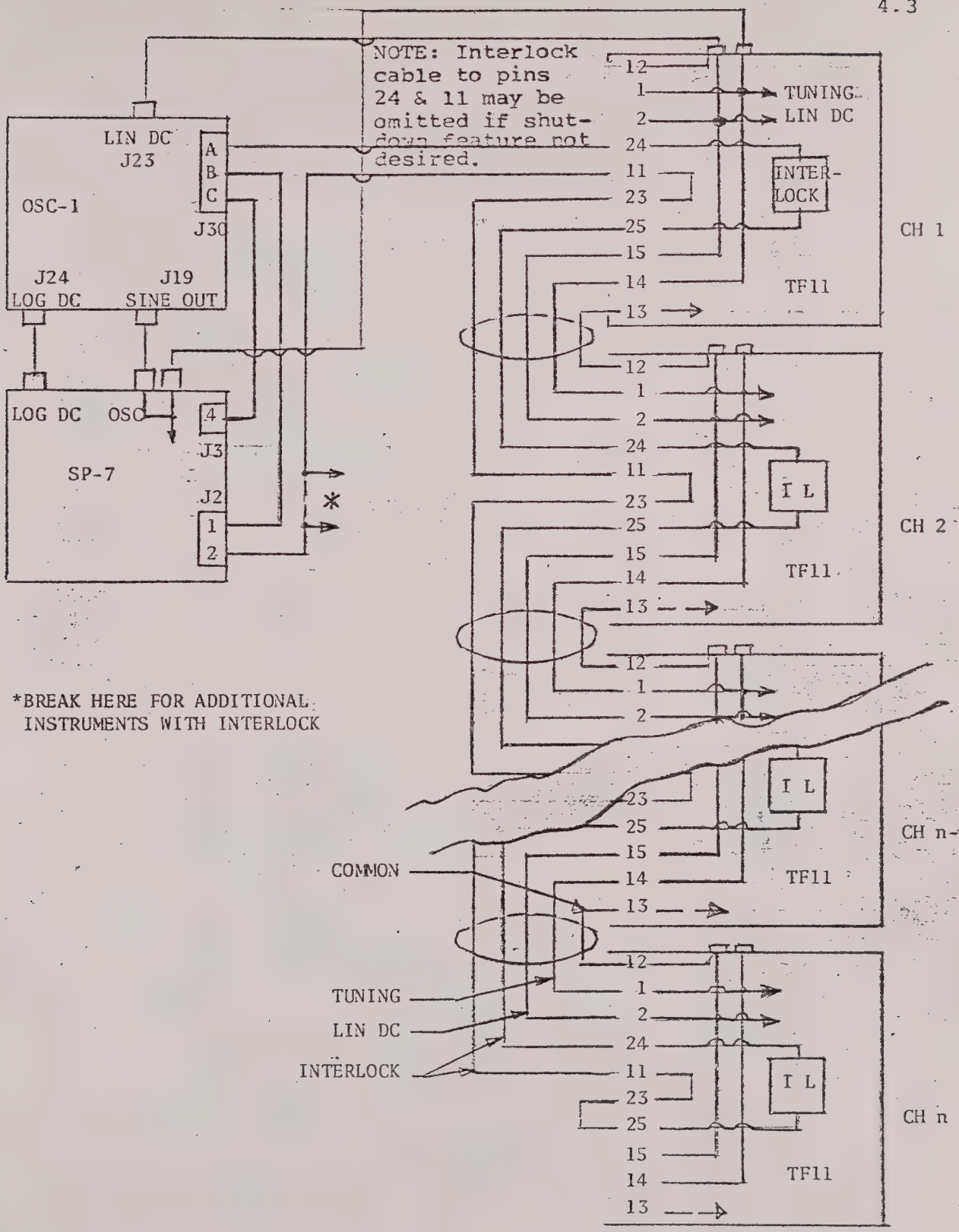
4.6.2 SD104A-5 on Ranges other than X1 (5 kHz) - Synonymous to 4.6.1 the bandwidth control will work properly only on the 5 kHz range (MULTIPLIER X1).

Solution: Use on MULTIPLIER X1 only or use TF11-L (with internal LIN DC generator) or consult factory for modification of TF11 (Option "-SD5").

4.6.3 SD104A-1 and SD104A-2 - Synonymous to 4.6.1 no MULTIPLIER setting will yield proper bandwidth control.

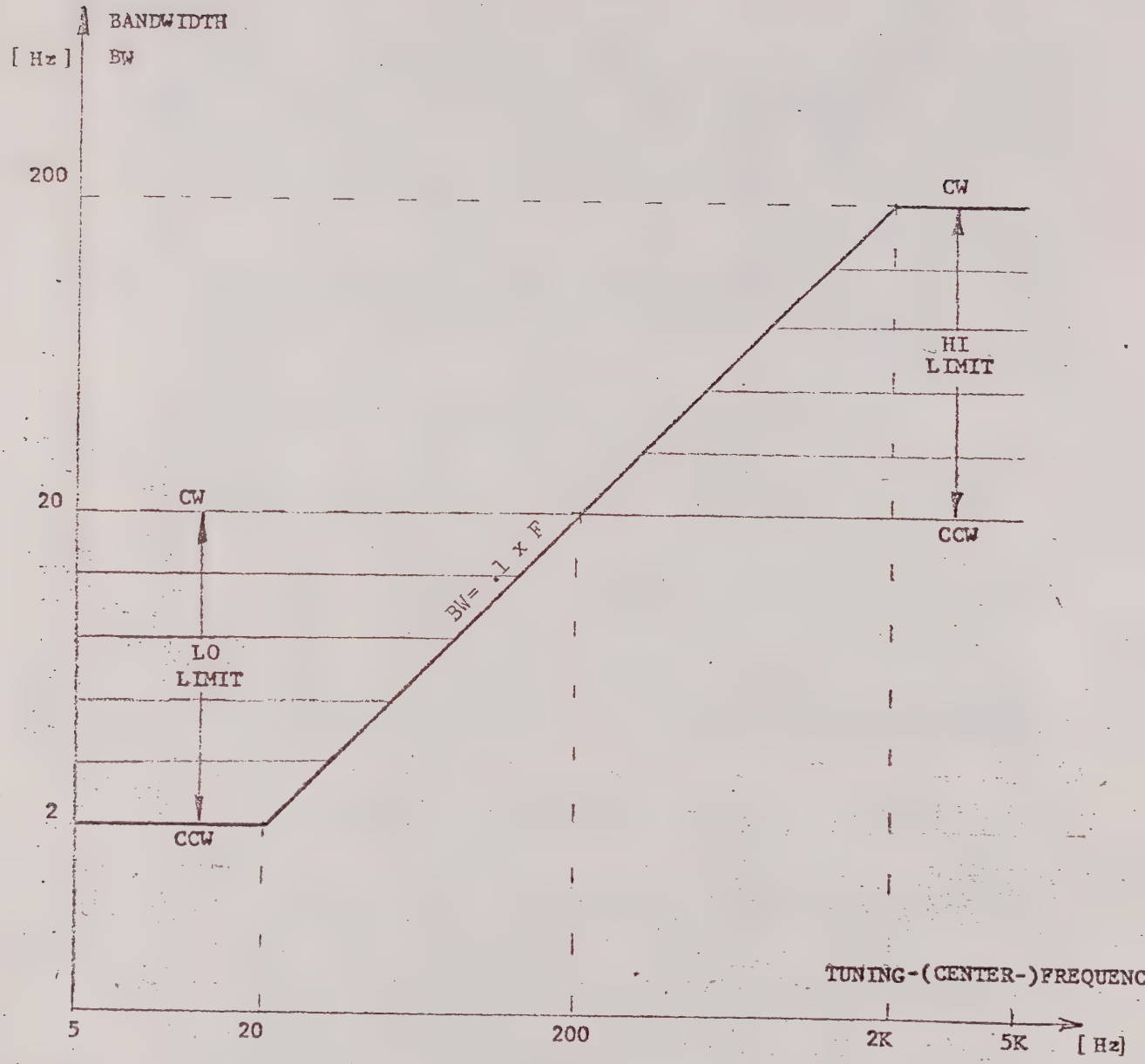
Solution: Use TF11-L (internal LIN DC generator) or consult factory for modification of TF11

4.6.4 SD114A - No precaution necessary.



TYP. INTERCONNECTION THROUGH AUX CONTROL CONN.

FIG 4.1



BANDWIDTH VS. TUNING-(CENTER-)FREQUENCY IN THE AUTO BANDWIDTH MODE

FIG. 4-2

4.6.5 B & K Auto Vibration Excitor Controls - Models 1016, 1018, 1019, 1008, 1025 - These instruments do not have a LIN DC vs. FREQUENCY Output. Also some models do not have a constant level output for use as TUNING Signal.

Solution: Be sure the B & K Controller has either internal constant level signal or external "COLA" unit (SD Model SD-11), and use TF11-L.

4.6.6 Others - Most other sine generators require the use of TF11-L. Also be sure a constant amplitude tuning signal .3V - 3V RMS is available.

4.7 Operation In A Typical System

4.7.1 Be sure tuning generator and TF11 are range compatible (See Section 4.6)

4.7.2 Apply power and let system warm up for at least 10 to 15 minutes.

4.7.3 Set TUNING Generator approximately to center of desired frequency range.

4.7.4 Switch TF11 to RANGE 300 g and adjust ZERO pots for minimum feed through of tuning signal (typical 2 mV rms or .3 g)

4.7.5 Set RANGE switch to max. expected acceleration. The TF11 has approx. 60 dB dynamic range when properly zeroed. Since many constant displacement tests require input variations of 45 dB it is important to select a range as close to the max accel. as possible to conserve usable range.

4.7.6 Set Bandwidth LIMIT pots (see Sec. 4.5 and 4.8). Normally LO LIMIT pot is set fully CCW, HI LIMIT pot fully CW. After adjustment select "AUTO".

4.7.7 Due to extreme noise signals (rattles in specimen or harmonic resonances) shutdown of Servo (SP-7) may occur due to overdriving the TF11. In that case select nearest high acceleration range on TF11.

4.8 DISPLACEMENT Mode

When using the TF11 over a larger dynamic range in the servo loop of a shaker system (such as constant displacement over a large frequency range), it may be desirable to bypass the filter as the signal approaches the noise floor. A Rear Panel switch (see Fig. 3.1) selects a mode in which the TF11

4.8 (cont'd)

goes into BYPASS when the tuning frequency goes below the LO LIMIT frequency. This mode is only active when the BANDWIDTH switch is at AUTO and the RANGE switch is at 30, 100, or 300g. (When used with D22-T, see also Section 4.9)

4.9 Operation With D22-T Charge Amplifier

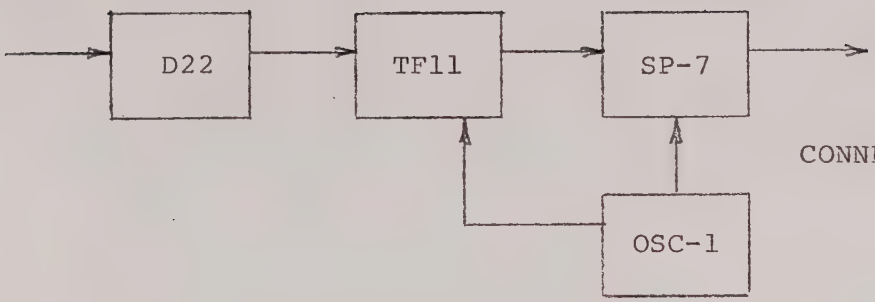
When using the TF11 with the Model D22-T Charge Amplifier (with tracking filter option) the ranges are shifted, since the signal from the D22 "TF" OUTPUT is not 10 mV/g, as it is from the "SERVO" OUTPUT. The used RANGE switch positions are as follows:

D22 RANGE	USE TF11 RANGE
1	10
3	30
10	100
30	300
100	300
300	300
1k	300

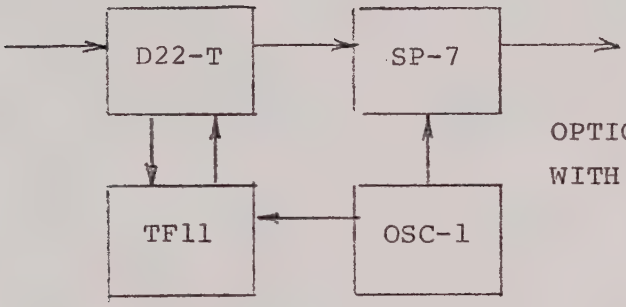
An overlay decal is available from U-D Corp., which can be affixed to the TF11 panel. It indicates in conjunction with a double pointed knob, both ranges (see FIG. 4.3).

Notice: When used with the D22-T the "Displacement Mode" of the TF11 may have to be changed. Sections 3.3.1 and 4.8 describe the "Displacement Mode". In this mode the TF11 goes automatically into BYPASS as the output signal approaches the noise floor. The "Displacement Mode" is not active on ranges 3g and 10g, since constant displacement tests over a large frequency range are unlikely in those acceleration ranges. Therefore it may be desirable to defeat the displacement mode on ranges 100g and lower (10g and lower on D22).

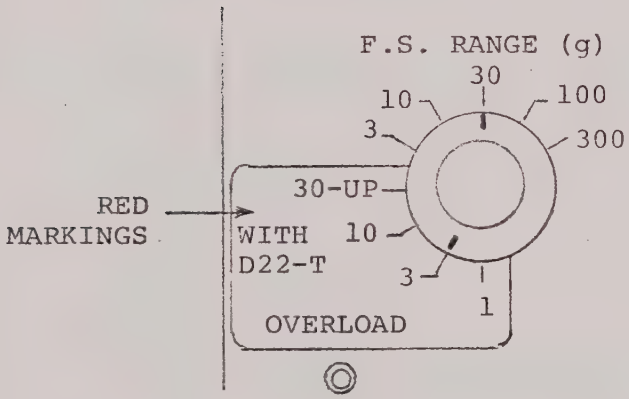
Although the DISPLACEMENT MODE switch can be used to enable or disable the "displacement mode", it is more convenient to rewire the RANGE switch as shown in Fig. 4.3 and Fig. 8.1.



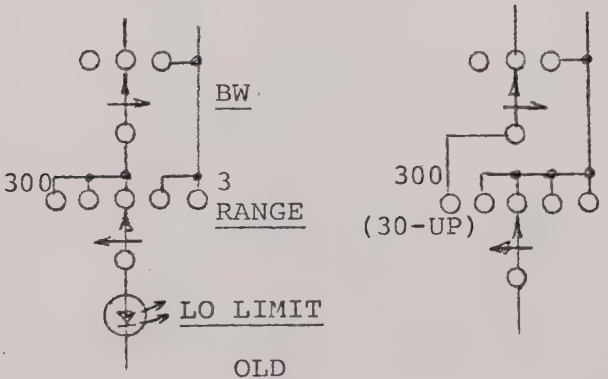
CONNECTION WITH D22



OPTIONAL CONNECTION
WITH D22-T



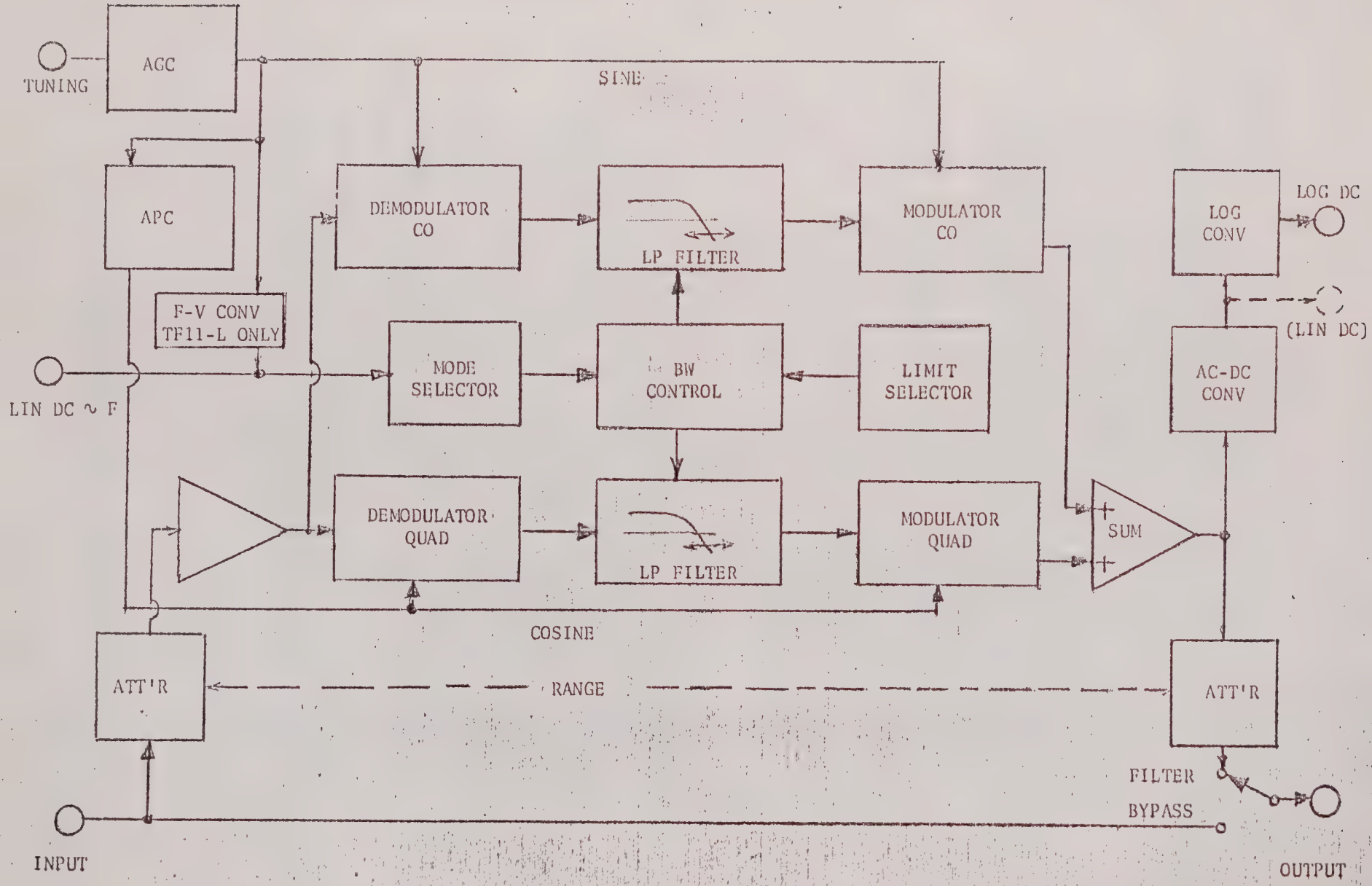
RANGE CONVERSION DECAL



MODIFICATION OF RANGE
SWITCH TO DEFEAT
DISPLACEMENT MODE ON
ALL RANGES EXCEPT 300g
(30-UP WHEN USED WITH D22-T)

OPERATION WITH D22-T (SEE SECTION 4.9)

FIG. 4-3



BLOCK DIAGRAM TF11

5. THEORY OF OPERATION AND CIRCUIT DESCRIPTION

A block diagram of the TF11 can be found in Fig. 5.1. Fig. 8.1 shows a detailed block diagram, and the circuitry of the individual PC boards is shown in Section 8.

5.1 Theory of Operation

For the purpose of description, it is assumed that the tuning frequency is 500 Hz (sin ωt) and the input signal contains a 500 Hz component of amplitude A and phase ϕ relative to the tuning signal [A sin ($\omega t + \phi$)] plus a distortion signal at 1000 Hz (B sin 2 ωt). A COSINE tuning signal (cos ωt) is generated in the TF11.

In the CO-demodulator the input signal is modulated by the SINE tuning signal and the output contains a:

Zero Hz component	A cos (ϕ)
1000 Hz component	A cos (2 $\omega t + \phi$)
500 Hz component	B cos (ωt)
1500 Hz component	B cos (3 ωt)

In the following filter all AC components are filtered out, and only the A cos ϕ component remains. Conversely, the filtered output of the QUAD-demodulator is A sin ϕ.

In the modulators the DC signals are modulated again by the SINE and COSINE signal. The outputs are A cos ϕ sin ωt and A sin ϕ cos ωt, the vector sum of which is A sin ($\omega t + \phi$), the 500 Hz component of the input signal.

5.2 Circuit Description

5.2.1 The Auto Gain and Phase Control (Board A) generates the SINE and COSINE for the CO and QUAD modulators (multipliers).

The TUNING signal, which may vary from .3 to 3V rms is amplified to 5V rms in Z1 (BoardA). A meter-integrator circuit controls the variable resistor V1 to stabilize the output voltage.

The SINE signal is phase rotated in the variable ALL-PASS, which rotates the phase vector of the SINE signal through the first and second quadrant depending upon frequency and value of V2. Z3 is a phase comparator. The average of the output signal at TP-2 is OV when the phase vectors of the two inputs (SINE and COSINE) are 90° apart. The error signal is integrated and fed back to V2, the control element of the ALL-PASS.

5.2.2 The I/O Buffer and Log Meter (Board B) contains amplifiers to buffer the normalized (attenuator) input signal and the restored (unity gain) output signal. A peak detector detects when the input signal exceeds the dynamic range of the TF11 Tracking Filter.

Z3, Z4 and Z5 comprise a log meter circuit which is connected to the normalized filter output.

5.2.3 Each of the Modulator Boards (DC and DQ) contain two multipliers connected as double balanced modulators.

The first modulator demodulates the input signal by multiplying the input signal by the reference SINE (COSINE) signal. The DC component of the signal at the output (pin K) is proportional to the CO (QUAD) component of the input signal. After filtering out all AC components in the LO-PASS filter the DC component is multiplied (modulated) by the reference SINE (COSINE) signal. The resulting CO (QUAD) signal is added to the QUAD (CO) signal of the other channel on the DC Board. The corresponding amplifier on the DQ Board removes the DC component of the filtered signal.

5.2.4 The Filter (Board F) is a dual channel voltage controlled LO-PASS.

The controlling signal is the LIN DC vs FREQUENCY signal from the TUNING generator (OSC-1). The two sections of Z1 limit this DC signal to the range set by the HI LIMIT and LO LIMIT controls. The EVRs (electrically variable resistors) are selected to track within 6 dB and the desired characteristic of resistance inversely proportional to frequency is obtained by placing one EVR (V1) in a feedback circuit.

The two filter sections have approximately three-pole Butterworth transfer function.

5.2.5 The optional (TF11-L only) LIN DC Connector (Board L) is a Frequency to Voltage converter.

The Sine reference signal is amplified proportional to frequency in a differentiating amplifier and then rectified in the following full wave rectifier.

6. MAINTENANCE & CALIBRATION

The instrument has been adjusted and calibrated at the factory and under normal conditions no readjustments except for front-panel ZERO adjustments are necessary. However, if prolonged use, customer calibration procedures, or major replacement of components make adjustments necessary, the procedure outlined in Section 6.1 through 6.6 with the instrument covers on should be followed. Remove the covers for further checking and adjustment only if malfunction or out-of-tolerance performance is suspected. ALLOW THE INSTRUMENT TO WARM UP AT LEAST 15 MINUTES BEFORE ATTEMPTING CHECKOUT OR CALIBRATION.

6.1 Instruments and Connections

Refer to the Table 6.1 below for instruments and to Table 6.2 for instrument connections.

DESCRIPTION	TYP. MODEL	USE
Sine Generator - 5 Hz to 5 kHz .3V to 3V rms Linear DC vs Frequency Output	U-D OSC-1	TUNING Generator
Sine Generator - 5 Hz to 5 kHz 5 mV to 5V rms variable	U-D OSC-1 (#2) HP Model 204D	SIGNAL Generator
AC Voltmeter Oscilloscope	HP Model 400EL HP Model 1202B	Monitor Signal Amplitudes And Waveshapes
DC Monitor	HP Model 7035B (plotter) Keithley Mod 168 (Auto DVM)	Measure LOG DC Output
Ratio Transformer (Optional)	Singer RT-20R	Varies signal precisely without changing oscillator input

TABLE 6.1 INSTRUMENTS

FROM	TO
TUNING gen. (AC out)	X AXIS Oscilloscope TF11 TUNING input
TUNING gen. (lin DC vs freq)	TF11 LIN DC input (not req'd for TF-11L)
SIGNAL gen. (AC out)	TF11 INPUT
AC voltmeter	Oscilloscope Y-AXIS
Oscilloscope Y AXIS	Point Monitored
DC Monitor	TF11 LOG DC output

TABLE 6.2 CONNECTIONS

The optional ratio transformer can be used between the SIGNAL generator and the TF11 input to provide a precisely set AC voltage without having to continually change the SIGNAL generator output.

6.2 OUTPUT ZERO (covers on)

Provide: SIGNAL input - zero (signal source connected or input shorted)
TUNING input - 500 Hz ≈ 1V rms
F.S. RANGE - 300g

Monitor: OUTPUT

Adjust front-panel ZERO potentiometers for minimum output. Refer to Fig. 6.1 for proper adjustment. If ZERO adjustment cannot be made from front panel, refer to Section 6.7.

6.3 OUTPUT ENVELOPE (covers on)

Provide: SIGNAL input - 502 Hz, 1.00 V rms
TUNING input - 500 Hz, ≈ 1 V rms
300 g range; HI-LIMIT bandwidth (CW)

Monitor: TF-11 output

Average output should be 1.00 V ±1% and variation of gain as Lisajous pattern rolls over and over should be within ±1.5%. Refer to Fig. 6.2 for typical output patterns and corrective adjustments if any.

Decreasing F.S. RANGE to 30 g should cause OVERLOAD indicator to flash.

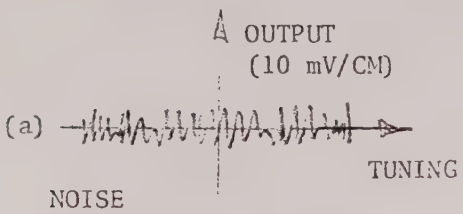
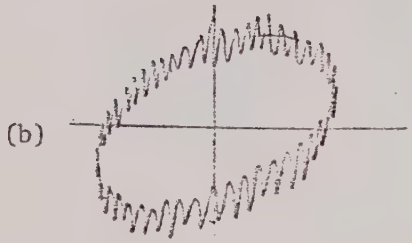
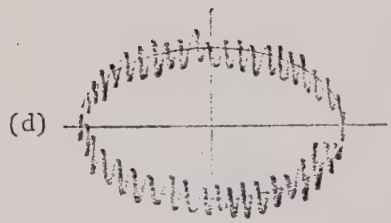
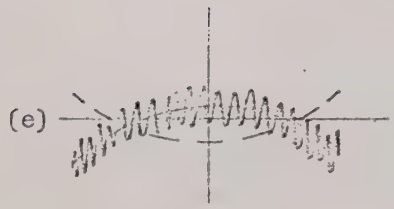
LISAJOUS PATTERN	COMMENTS	REMEDY
(a) 	Zero properly adjusted	None needed
(b) 	CO & QUAD ZERO not properly adjusted	Adjust both front panel ZERO potentiometers
(c)	CO ZERO not properly adjusted	Adjust upper front panel ZERO potentiometer
(d) 	QUAD ZERO not properly adjusted	Adjust lower front panel ZERO potentiometer
(e) 	OUTPUT COMP. not properly adjusted	Remove top cover Refer to Section 6.7

FIG. 6.1 OUTPUT ZERO ADJUSTMENT LISAJOUS PATTERNS
ZERO SIGNAL INPUT - 300g F.S. RANGE

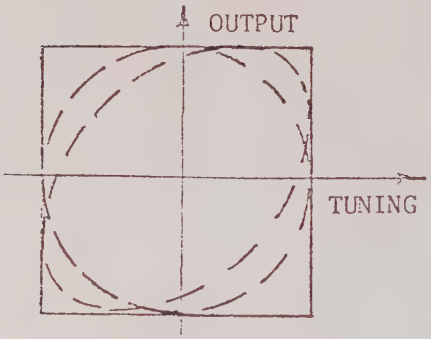
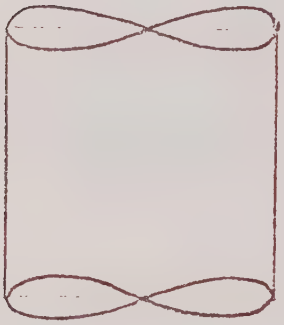
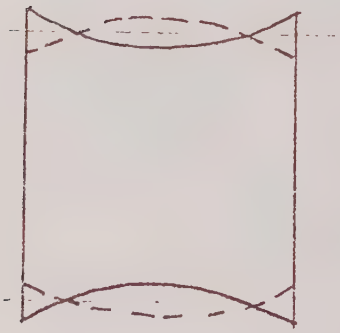
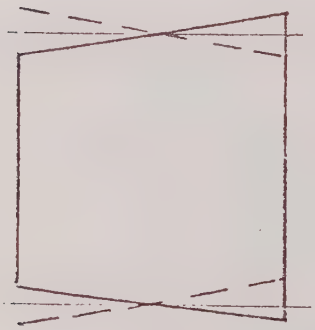
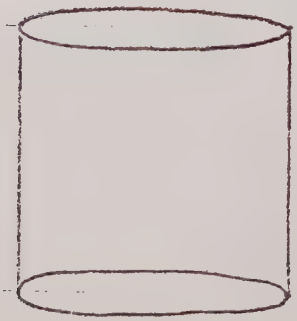
MODULATION ENVELOPE	COMMENTS	REMEDY
(a) 	Output properly adjusted Av. gain = 1.0 ±1% Gain Δ < ±1.5%	None needed
(b) 	Phase not correctly adjusted. Gain variation with phase noted in 6.3.	Adjust PHASE through top cover to minimize gain variation
(c) 	Gain Balance not correctly adjusted. Gain variation with phase noted in 6.3.	Adjust GAIN BALANCE through top cover to minimize gain variation. Adjust GAIN to re-establish unity gain.
(d) 	CO Flatness not correctly adjusted. Does not cause gain variation with phase	Remove top cover. Refer to Fig. 6.3. Adjust FLATNESS on D-C Card.
(e) 	QUAD Flatness not correctly adjusted. Does not cause gain variation with phase. Should gain variation be noticed, check ZERO (section 6.2)	Remove top cover. Refer to Fig. 6.3. Adjust FLATNESS on D-Q Card.

FIG. 6.2 OUTPUT ENVELOPE LISAJOUS PATTERNS

Should average output fall outside 1.00V ±1%, readjust GAIN through top cover. Should GAIN adjustment through top cover be inadequate, refer to Section 6.10.

Failure to provide a rectangular output modulation envelope as in Fig. 6.2 (a), but one that pulses or looks like a "bow tie" indicates that either the CO or the QUAD modulator card (D-C or D-Q) may be faulty. Proceed to Section 6.13.

Excessive phase error patterns, even at very small frequency differences, indicates a problem on the FILTER CARD F. Proceed to Sections 6.11, 6.12 and 6.13.

6.4 FREQUENCY RESPONSE (covers on)

Provide: SIGNAL input - 1.00 V rms
TUNING input - ∿ 1 V rms
HI LIMIT (where requested) - CW (200 Hz)
LO LIMIT (where requested) - CCW (2 Hz)
F.S. RANGE - 300 g

TUNING (Hz)	SIGNAL (Hz)	AVERAGE OUTPUT (rms)	GAIN VARIATION	BANDWIDTH
5000	5002 - 5005	1.00 V ±3%	±3%	HI-LIMIT
50	50.1 - 50.2	1.00 V ±3%	±1.5%	LO-LIMIT
5	5.1 - 5.2	1.00 V ±3%	±3%	LO-LIMIT

The small differences in SIGNAL frequency and TUNING frequency that are required can be obtained by varying one or the other until the Lisajous pattern rolls over and over at the approximately required difference frequency.

Should excessive gain variation with phase occur at the extremes of the frequency band refer to Sections 6.11 and 6.12.

6.5 FILTER BANDWIDTH (covers on)

Provide: SIGNAL input - 600 Hz 1.00 V rms
TUNING input - 500 Hz ≈ 1 V rms
F.S. RANGE - 300 g
HI-LIMIT - CW (200 Hz)

Monitor: OUTPUT

The measured value of output should be approximately 0.6 - 0.8 V rms. The modulation envelope may be slightly distorted, as in Fig. 6.2 (b) and (c). This is acceptable, as it is impossible to match the filter skirts of the CO and QUAD channels exactly with EVR's.

Provide: SIGNAL input 51.0 Hz 1 V rms
TUNING input 50.0 Hz ∿ 1V rms
300 g F.S.
LO-LIMIT BW CCW - (2 Hz)

Monitor: OUTPUT on Y Axis (TUNING ON X-Axis)

The measured average value of the output should again be 0.6 to 0.8 V rms and some distortion on the modulation envelope is acceptable.

If replacement of EVR(s) is needed, a matched set must be supplied for Card F, although a single failed EVR may often be replaced by changing the EVR's around in the circuit, and performing the checks above.

6.6 LOG DC (covers on)

Provide: Check ZERO balance
SIGNAL input - 22.4 mV rms 505 Hz
TUNING input - ∿ 1V rms 500 Hz
HI-LIMIT CW (200 Hz)

Monitor: LOG DC output

The following values of LOG DC output should be noted as function of F.S. RANGE

F.S. RANGE (g)	3	10	30	100	300	TOLERANCE
LOG DC (1V/decade)	0	-.500V	-1.00V	-1.50V	-2.00V	±13 mV
LOG DC (60 mV/decade)	0 mV	-30 mV	-60 mV	-90 mV	-120 mV	±1 mV

Should any of the reading be out of tolerance, remove the top cover and refer to Section 6.16.

****

The following sections are used only to pinpoint malfunctions or to correct for out-of-tolerance performance. The adjustments are made at the factory and normally do not have to be done again. Remove the covers before proceeding and refer to Fig. 6.3 for the location of various adjustments and circuit boards. THE FOLLOWING SECTIONS ARE NOT PART OF THE NORMAL CALIBRATION PROCEDURE.

****

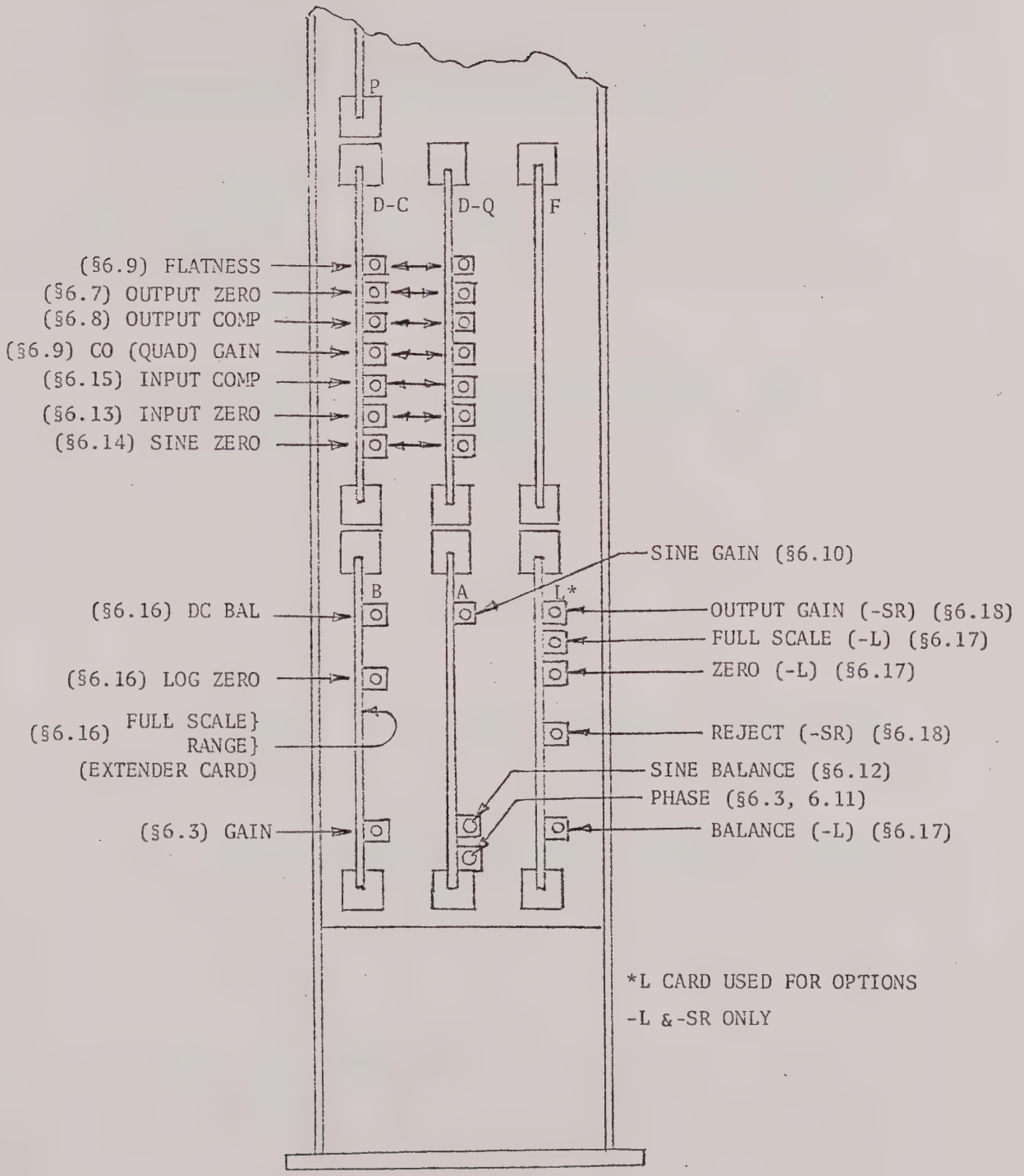


FIG. 6.3

TOP VIEW OF TF-11 WITH COVER REMOVED

ADJUSTMENT LOCATIONS SHOWN

AND SECTION REFERENCES

6.7 OUTPUT ZERO (Cards D-C and D-Q)

Should adjustment be impossible to make from the front panel, turn both front panel pots full CCW and then turn both ten turns CW. With the same setup as in Section 6.2 adjust the OUTPUT ZERO potentiometers on the D-C and D-Q cards for minimum output.

Should the OUTPUT ZERO adjustment be particularly unstable or the internal potentiometer adjustment is insufficient, check to see that the heaters are working on the multipliers mounted on the D-C and D-Q cards under the sponge insulators. Consult factory if the trouble is not apparent.

6.8 OUTPUT COMPENSATION (Cards D-C and C-Q)

With the conditions the same as in 6.2, excessive curvature in the ZERO output Lisajous pattern (second harmonic output) as in Figure 6.1 (e) requires correction by adjusting the OUTPUT COMP. potentiometer on either the D-C or D-Q card.

6.9 FLATNESS, GAIN BALANCE (Cards D-C & D-Q)

Refer to Fig. 6.2 and Section 6.3 for test conditions. Either CO or the QUAD GAIN potentiometer may be used to adjust the GAIN BALANCE needed in Fig. 6.2 (c).

6.10 SINE GAIN (Card A)

If the GAIN adjustment in Section 6.3 is insufficient to establish unity gain, set GAIN potentiometer (Card B) to middle range and adjust SINE GAIN for unity gain as in Section 6.3.

Monitor voltage at TP-1 (see Component Layout Card A). The value is not critical, but should generally be 5V rms ±10%. The value should be constant as the TUNING input is varied from .3 to 3V rms after AGC action has occurred.

Adjustment of the SINE GAIN may require readjustment of the SINE BALANCE in Section 6.12.

6.11 PHASE (Card A)

Perform the following if excessive gain variation with phase occurs at 5 Hz or 5 kHz after the PHASE adjustment has been properly made at 500 Hz as described in Section 6.3 and Fig. 6.2 (b).

Monitor TUNING or TP-1 on X-Axis
TP-3 on Y-Axis

Switch tuning frequency successively from 5 to 50 to 500 and finally to 5000 Hz. The amplitude at TP-3 should remain at 5V rms ±10% and the Lisajous pattern should show the circle typical of 90° phase at each frequency after the APC takes a fraction of a second to correct after each frequency switching.

If 90° phase cannot be maintained at all frequencies, proceed to 6.12, but do not readjust the PHASE potentiometer.

6.12 SINE BALANCE (Card A)

Monitor: TUNING on X-Axis
TP-2 on Y-Axis

Switch TUNING frequency successively from 5 to 50 to 500 to 5000 Hz. The proper shape of the Lisajous pattern is shown in Fig. 6.4 after APC correction.

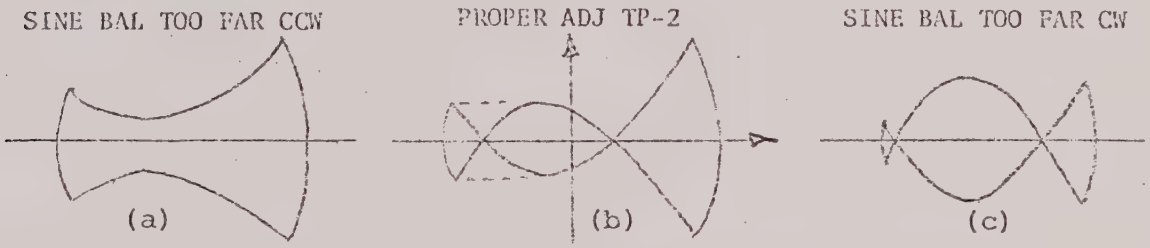


FIG. 6.4 BALANCE OF PHASE DETECTOR-LISAJOUS PATTERNS

A little rounding of the sharp corners of the pattern is to be expected at 5 kHz. Adjust SINE BALANCE for the equal lobes as shown in Fig. 6.4 (b). Readjust PHASE as in Section 6.3.

If 90° phase cannot be maintained in 6.11 and 6.12, replacement of V2 (light-controlled resistor) may be attempted as a solution. A factory-supplied low-distortion unit is necessary here.

6.13 INPUT ZERO (Cards D-C & D-Q)

Provide: Zero SIGNAL input
TUNING signal - 500 Hz 1V rms

Monitor: TP-C (Card F)

Adjust INPUT ZERO (Card D-C) for minimum first harmonic signal

Monitor: TP-Q (Card F)

Adjust INPUT ZERO (CARD D-Q) for minimum first harmonic signal. Refer to FIG. 6.5 for proper modulation envelope with SIGNAL input = 1.00V rms (300g range) 505 Hz.

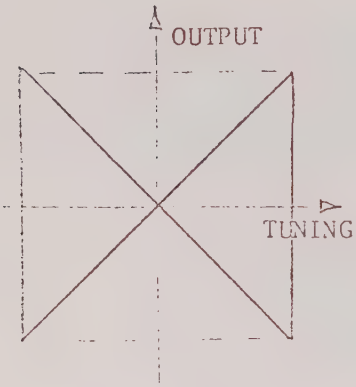
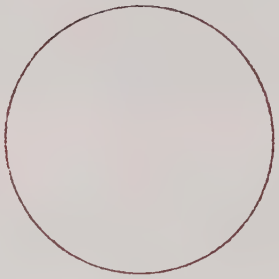
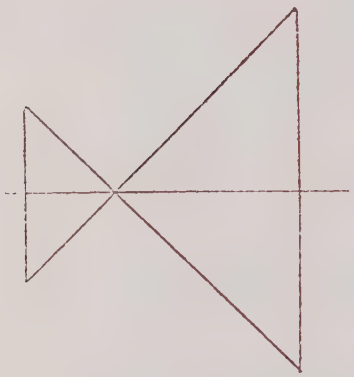
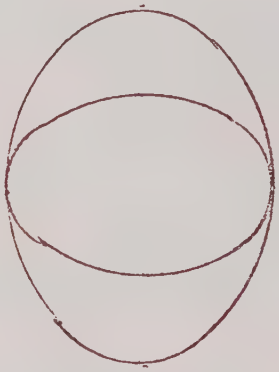
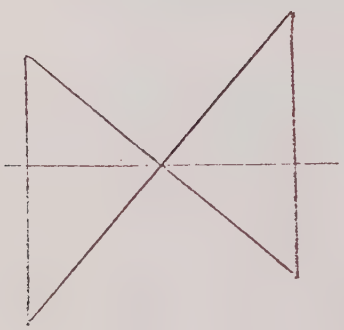
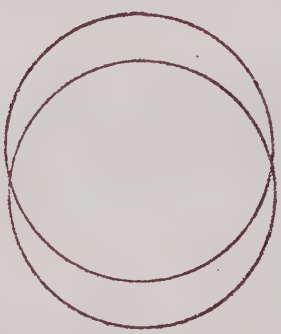
CO OUTPUT (TP-C)	QUAD OUTPUT (TP-Q)	COMMENTS
		Properly Adjusted Equal Lobes
		SINE ZERO improperly adjusted. See section 6.
		INPUT ZERO improperly adjusted. See section 6.12.

FIG. 6.5

LISAJOUS PATTERNS

MODULATOR OUTPUT ENVELOPES

If proper signal pattern is absent, replace multiplier Z2 on appropriate card.

6.14 SINE ZERO (Cards D-C & D-Q)

Provide: SIGNAL input - 505 Hz 1V rms
TUNING input - 500 Hz ∿ 1V rms
300g F.S. RANGE

Monitor: TP-C and TP-Q (Card F)

Refer to Fig. 6.5 and adjust SINE ZERO on TP-C and TP-Q to establish equal lobes on modulation envelope.

Any readjustment in Sections 6.13 and 6.14 requires a re-examination of the OUTPUT envelope as in Section 6.3.

6.15 INPUT COMPENSATION (Cards D-C & D-Q)

This adjustment has little effect and need not be readjusted.

6.16 LOG DC (Board B) (7)

Provide: SIGNAL input - 22.4 mV rms, 505 Hz
TUNING input - 1V rms, 500 Hz
HI-LIMIT - CW (200 Hz)

(Make sure ZERO output adjustment is accurately done)

Monitor TP-2 (Card B) with oscilloscope. Adjust DC BAL (CARD B) until peak value of half-wave rectified shape on 300g F.S. RANGE is 1% (∿30 mV pk) of peak value on 3 g F.S. RANGE (∿3V pk).

Then monitor LOG DC output.

On: 3g RANGE adjust FULL SCALE for 0V output (±13 mV)
30g RANGE adjust RANGE for -1.000 VDC output
300g RANGE adjust LOG ZERO for -2.000 VDC output

Repeat above steps until correct readings are obtained (see table in Section 6.5). An extender card is required.

6.17 LIN DC GENERATOR (Card L - L Option only)

Monitor and make adjustments in Table below.

TUNING freq (Hz)	MONITOR	ADJUST Potentiometer	MEASURE
20	TP-1 Card L	BAL	equal half sine waves
2,000 Hz	LIN-DC out	FULL SCALE	4V DC
20	LIN-DC out	ZERO	40 mV DC

6.18 SINE REJECT (Card L - SR Option only)

Provide: TUNING input - 500 Hz 1V rms
SIGNAL input - 550 Hz 1V rms
BW to LO LIMIT (CCW - 2 Hz)

Monitor: SINE REJECT output

Adjust: OUTPUT GAIN pot (Card L) for unity gain (out-of-band signal)

Then put BW to HI-LIMIT (CW-200 Hz), SIGNAL input to 500.5 Hz ($\Delta f \simeq .5$ Hz.)

Adjust: REJECT pot. (Card L) for minimum output (in band signal).

7. REPLACEMENT PARTS

7.1 General

Whenever possible standard electronic components have been used in this instrument. Most standard components can be purchased locally. Difficult to find components and special components are listed in Section 7.2; however, common components such as carbon composition resistors (10%) carbon film resistors (1%), and most capacitors are not called out in this replacement parts list. When ordering replacement parts or subassemblies from Unholtz-Dickie Corporation, please always include:

a) complete description of item ordered
b) schematic reference number, if assigned
c) description of assembly in which part is used
d) model and serial number of instrument

Alternate Parts may be substituted in some cases where availability and pricing warrant. In particular in the case of semiconductors several manufacturers may make almost identical items or identical items under different part numbers. Section 7.3 lists some of the alternate parts that may be found in a particular instrument.

7.2 Replacement Parts List

7.2.1 Chassis Assembly

FRONT PANEL MOUNTED PARTS

SOURCE	PART NO	DESCRIPTION	QTY
U-D CORP	ASM-1033A	5 Pole 5 pos. rotary switch	1
U-D CORP	ASM-1033A	2 Pole 3 pos. rotary switch	1
C & K	7301 KBE	3PDT Toggle Switch	1
BOURNS	A3059J-1-103M	25 turn screwdriver potentiometer 10K	4
KINGS	UC79-45	BNC Connector	2
GENERAL ILLUMINATION	4000-2	LED indicator	3

BACK PANEL MOUNTED PARTS

SOURCE	PART NO.	DESCRIPTION	QTY
U-D CORP		(line cord)	
CINCH	P-303-LAB	line voltage	1
CINCH	S-303-CCT	(mating connector)	
BUSSMAN	HWA-AF	Fuse Holder	1
BUSSMAN	GMW 1/2	Fuse ½A	1
ALCO	MSS-22	DPST Slide Switch	1
KINGS	KC79-35	BNC Connector	5
CANNON	DBC-25S	25 Pin "D" Connector	1
CANNON	DBC-35P	(mating connector)	

CHASSIS MOUNTED PARTS

U-D CORP	T-79	Transformer	1
P & B	E10-Z4-J1.OK	Relay	2
AMPHENOL	143-022-01-100	PC Connector	6
AMPHENOL	143-018-01-100	PC Connector	1
SPRAGUE	TVL 1220	500 F/25V Capacitor	2
ALCO	MST-115D	SPDT Switch	1

7.2.2 Plug-in Subassemblies

	Card A-TF11	Auto Gain Control	
			2
BARNES	831-55022-084	1C Socket 8 pin	1
INDUSTRIAL ELECTRONIC HARDWARE	MPT 6005-1	Transistor socket 5 pin	2
FAIRCHILD	uA 74	Dual Op-AMP	1
RCA	CA3080	OP-AMP	1
VAC-TECH	VTL2C2	Electrically variable Resistor (EVR) (Selected)	2
SYLVANIA	1N914	Diode	4
BECKMAN	89WR10K	Trimmer Pot 10K	2
BECKMAN	89WR50K	Trimmer Pot 200K	1
MOTOROLA	MC1458CP1	Dual Op. Amp	2
ANALOG DEV	AD540J	FET Op. Amp	1

CARD B-TF11 BUFFER AND METER

SOURCE	PART NO.	DESCRIPTION	QTY
BARNES	821-20011-144	IC Socket 14 pin	4
BARNES	831-55022-104	IC Socket 10 pin	1
INDUSTRIAL ELECTRONIC HARDWARE	MPT 6003	Transistor Socket 3 pin	1
FAIRCHILD	µA 747	Dual Op-AMP	4
FAIRCHILD	µA 726	Dual Heated Transistor	1
TI	2N 699	NPN Transistor	1
SYLVANIA	IN 914	Diode	5
BECKMAN	89 WR200	Trimmer Pot 200Ω	2
BECKMAN	89 WR10K	Trimmer Pot 10K	2

CARD D-TF11 MODULATOR

BARNES	821-20011-144	IC Socket 14 pin	1
BARNES	821-20011-164	IC Socket 16 pin	2
FAIRCHILD	µA 747	Dual Op-AMP	1
MOTOROLA	MC1494	Multiplier	2
BECKMAN	89 WR 10K	Trimmer Pot 10K	1
BECKMAN	89 WR 20K	Trimmer Pot 20K	4
BECKMAN	89 WR 50K	Trimmer Pot 50K	2
U-D	175Q14111	Thermistor	2
U-D	A12031	Thermal Boot	2

CARD F-TF11 FILTER

BARNES	821-20011-144	IC Socket 14 pin	2
IND ELECTR HARDWARE	MPT 6005-1	Transistor Socket 5 pin	7
IND ELECTR HARDWARE	MPT 6003	Transistor Socket 3 pin	3
FAIRCHILD	µA 747	Dual OP-AMP	2
VAC-TECH	(VTL-2C2)	Set of 7 selected VTL 2C2 Electrically Variable Resistor (EVR)	1

CARD F-TF11 FILTER (cont'd)

SOURCE	PART NO.	DESCRIPTION	QTY
FAIRCHILD	2N 699	NPN Transistor	2
TI	2N 4998	PNP Transistor	1
INTERSIL	IH-8007	FET-OP-AMP	2
SYLVANIA	IN 914	Diode	3

CARD L-TF11 LIN DC GENERATOR (Optional)

BARNES	821-20011-144	IC Socket 14 pin	2
FAIRCHILD	MA 747	Dual OP-AMP	2
SYLVANIA	IN 914	Diode	2
BECKMAN	89WR10K	Trimmer Pot 10K	3

CARD P-TF11 POWER SUPPLY

BARNES	821-20011-144	IC Socket 14 pin	2
IND. ELEC. HARDWARE	MPT 6003	Transistor Socket	1
FAIRCHILD	µA 723	Power Supply Regulator	2
FAIRCHILD	2N 4889	PNP Transistor	1
RCA	40389	NPN Power Transistor	1
RCA	40410	PNP Power Transistor	1
WESTINGHOUSE	IN5353	Rectifier Diode 300V	4

7.3 Alternate Parts

Due to availability and pricing some parts, in particular semiconductors, of a different manufacture and different part numbers may be substituted. The following is a list of some of the alternate parts that may be used. The first part listed in each group is the part originally used by Unholtz-Dickie, which is not necessarily the first introduced part. Parts marked with an asterisk (*) are not a direct replacement, but may be substituted in this instrument.

7.3.1 FET-OP-Amp

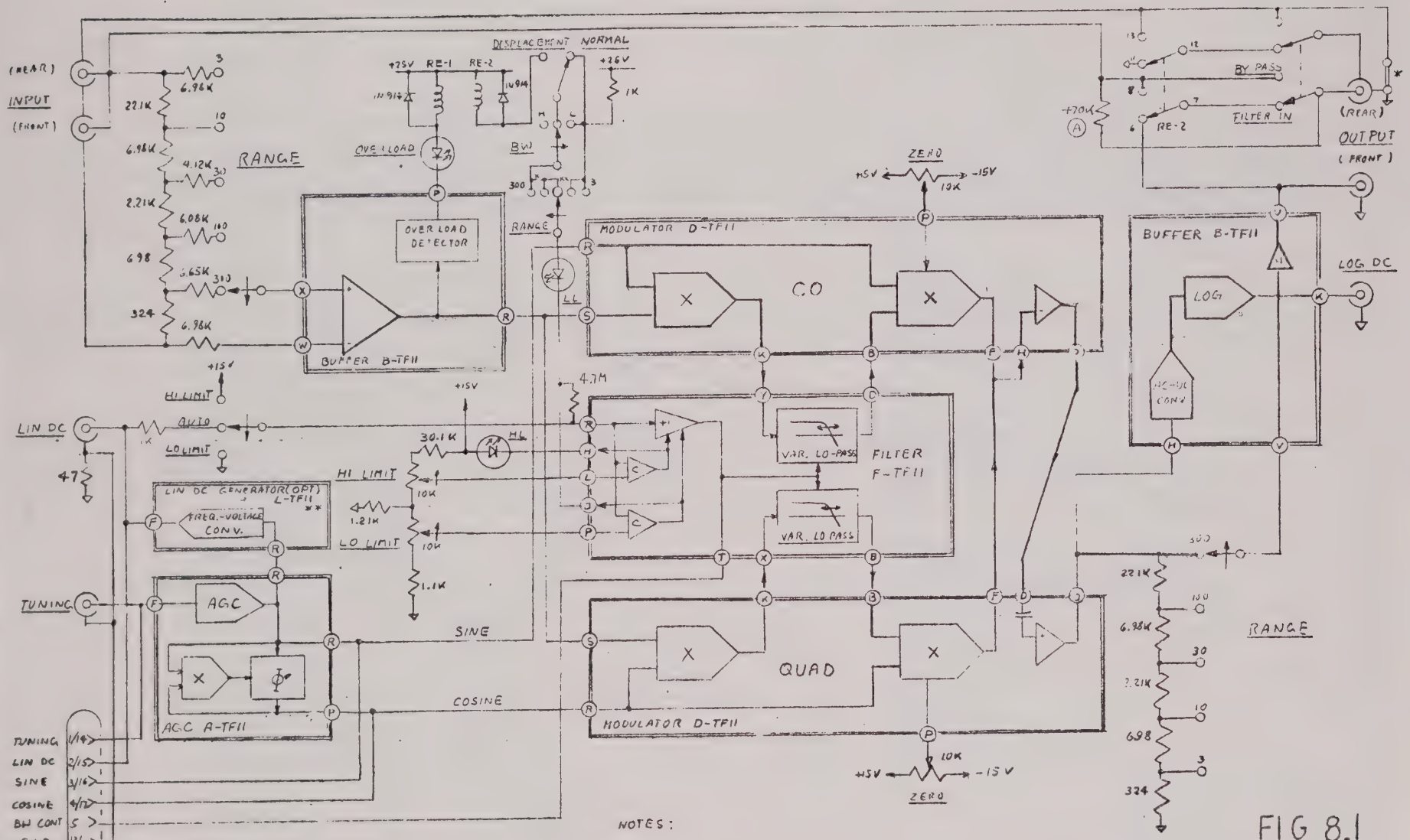
SOURCE	PART NO.
INTERSIL	ICL8007C
SIGNETICS	NE 536 T
FAIRCHILD	µA 740 (*)
ANALOG DEVICES	AD-540
TELEDYNE	1421

8. SCHEMATICS AND LAYOUT DIAGRAMS

S.N. 396

FIG.	TITLE	DWG. NO.	REV.
8-1	SIGNAL SCHEMATIC MODEL TF11	C12055	A
8-2	AUTO GAIN CONTROL SCHEM. A-TF11	B12085	A
8-3	COMPONENT LAYOUT A-TF11	D12082	NC
8-4	I/O BUFFER SCHEM B-TF11	B12064	E
8-5	COMPONENT LAYOUT B-TF11	A12065	E
8-6	MODULATOR SCHEM. D-TF11	B12066	NC
8-7	COMPONENT LAYOUT D-TF11	A12067	NC
8-8	FILTER SCHEM. F-TF11	B12017	F
8-9	COMPONENT LAYOUT F-TF11	A12043	C
8-10	POWER SUPPLY SCHEM P-TF11	B12080	A
8-11	COMPONENT LAYOUT P-TF11	A12079	A
8-12	LIN DC GEN. SCHEM. L-TF11	A12048	A
8-13	COMPONENT LAYOUT L-TF11	A12028	C

REV: 11/5/74
REV: 6/17/75



NOTES:

ALL BOARDS HAVE +15 ON PIN A (1)
GND " " M (11) & N (12)
-15 " " Z (22)

FOR POWER SUPPLY SEE B 12019

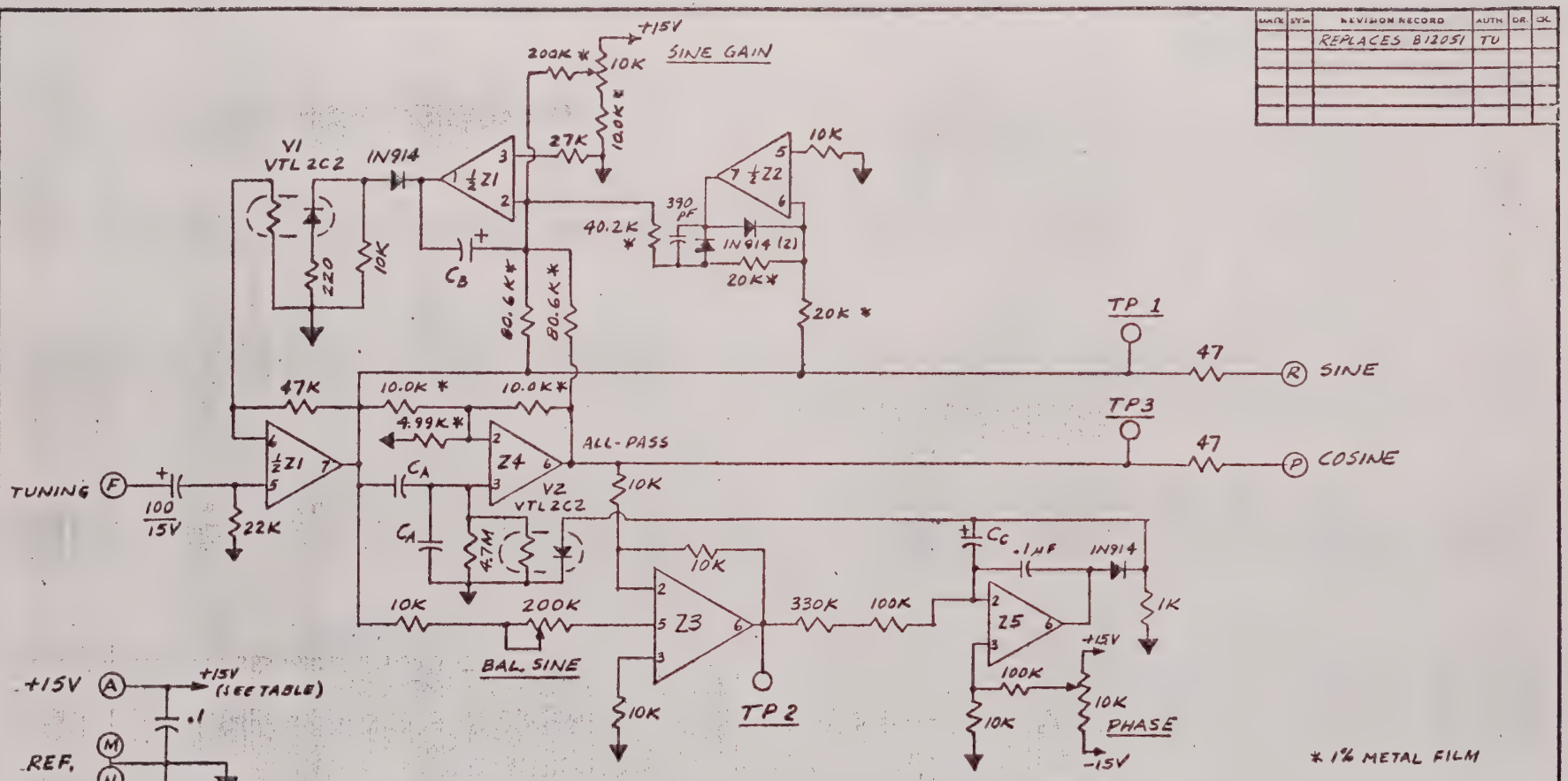
* REMOVE JUMPER FOR DIFF OPERATION

** BD L-TF11 USED ON TF11-L ONLY

(A) * FOR OPERATION WITH D22-T REMOVE JUMPER (K) AND ADD (**)

FIG 8.1

TOLERANCES (UNLESS OTHERWISE NOTED)	U-D CORP
DECIMAL ±	SCALE
FRACTIONAL ±	TITLE SIGNAL SCHEMATIC TF11
ANGULAR ±	DATE 12-2-73 DRAWING NUMBER C 12055



MODEL	C_A	C_B	C_C	
TF11	.022	100/15V	10/20V	
TF11-F2	.047	100/15V	22/10V	
TF11-F1	.10	2x100/15V	47/10V	

	I.C.	+15V	-15V
Z1	MC1458 CP1	PIN 8	PIN 4
Z2	MC1458 CP1	8	4
Z3	CA 3080	7	4
Z4	AD540J	7	4
Z5	μA 741	7	4

REVISION RECORD	AUTH	DR.	CK.
REPLACES B12051	TU		

TOLERANCES (EXCEPT AS NOTED)
DECIMAL ±
FRACTIONAL ±
ANGULAR ±

UNHOLTZ-DICKIE CORP.

SCALE —
DRAWN BY TU
APPROVED BY

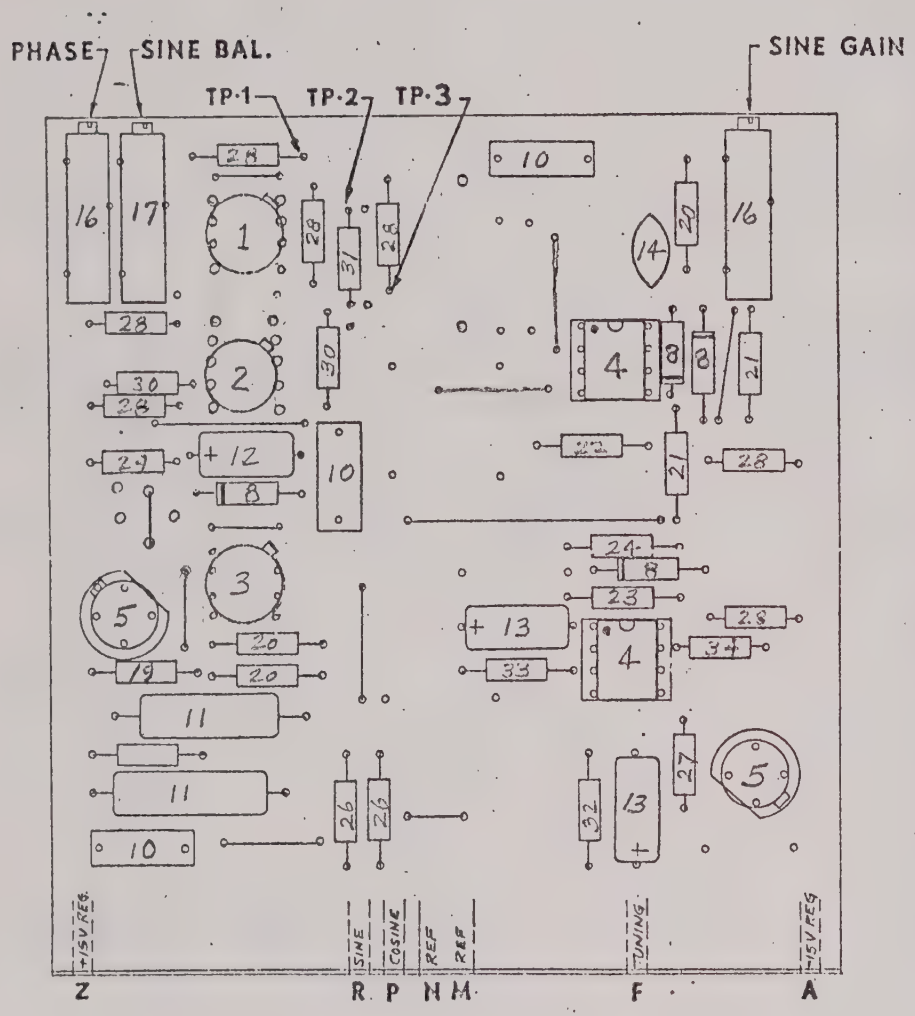
A-TF11

TITLE AUTO GAIN & PHASE CONTROL

DATE 1-12-75

DRAWING NUMBER B12085

FIG 8.2



A·TF 11

ITEM	QUAN	DESCRIPTION		ITEM	QUAN	DESCRIPTION	
1	1	CA3080		23	1	80.6K	1%
2	1	μA741		24	1	200K	V
3	1	AD540J		25			
4	2	MC1458CP1		26	2	47Ω	1/4W 10%
5	2	VTL2C2 (SEL.)		27	1	220Ω	"
6				28	7	10K	"
7				29	1	1K	"
8	4	IN914		30	2	100K	"
9				31	1	330K	"
10	3	0.1μF/50-100V		32	1	22K	"
11	2	.022μF/80V		33	1	27K	"
12	1	10μF/20V		34	1	47K	"
13	2	100μF/15V		35	1	4.7M	"
14	1	390pF		36			
15				37			
16	2	10K POT.		38			
17	1	200K POT.		39			
18							
19	1	4.99K	1%				
20	3	10.0K	"				
21	2	20.0K	"				
22	1	40.2K	"				

UNHOLTZ DICKIE CORP
A-TF11
COMPONENT LAYOUT
AUTO GAIN & PHASE CONTROL
1-10-75
212082

FIG 93

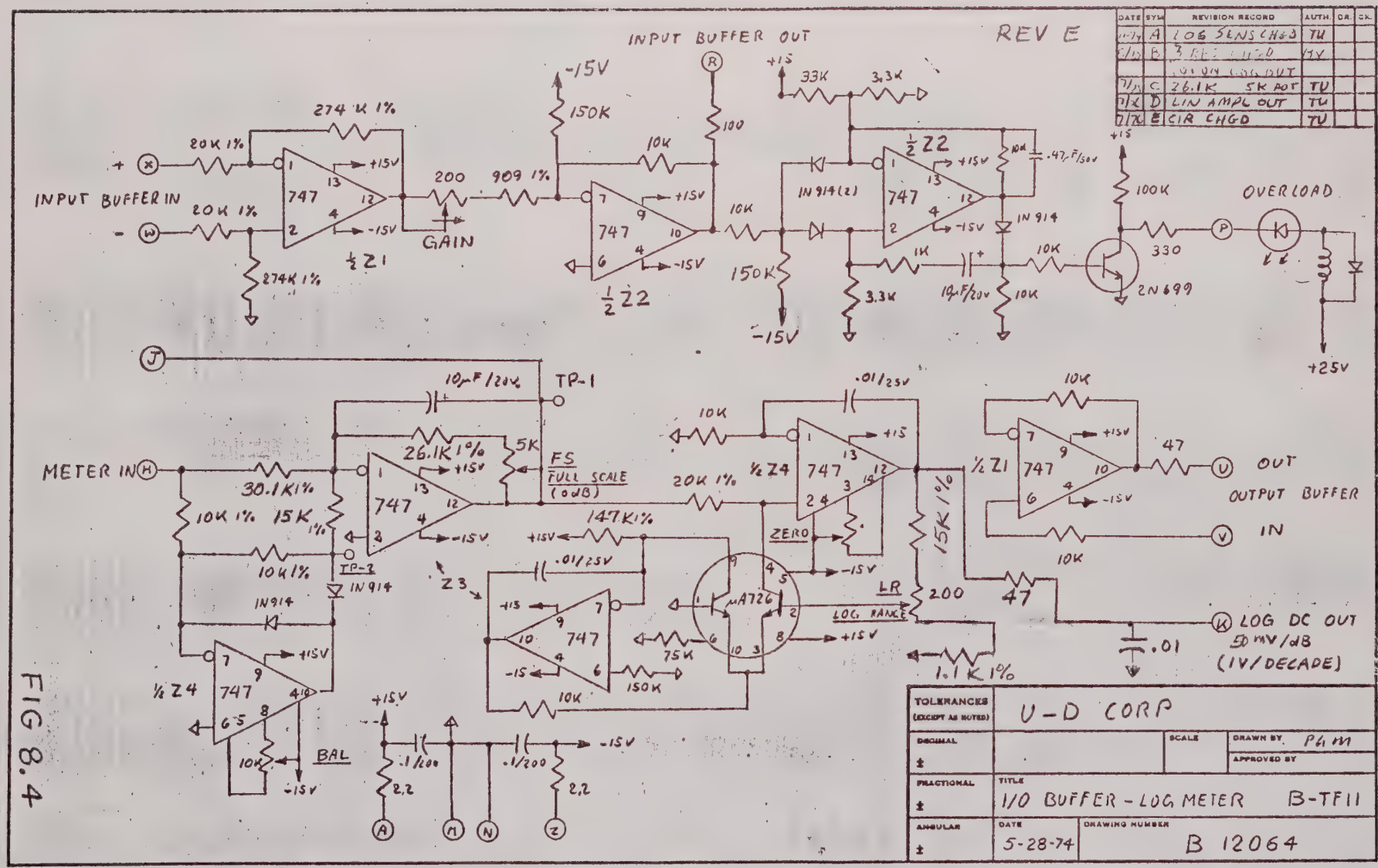

REV E
INPUT BUFFER OUT
INPUT BUFFER IN
METER IN
OVERLOAD
OUTPUT BUFFER
LOG DC OUT
50 mV/dB
(1V/DECADE)
FS
FULL SCALE
(0dB)
ZERO
LR
LOG RANGE
GAIN
BAL
TP-1
TP-2
747
μA726
2N699
IN914
274K 1%
20K 1%
26.1K 1%
30.1K 1%
10K 1% 15K
147K 1%
15K 1%
1.1K 1%
909 1%
150K
75K
3.3K
33K
100K
330
200
47
.01
10μF/20V
.47μF/50V
.01/25V
.1/200
2.2
-15V
+15V
+25V
½Z1
½Z2
Z3
½Z4
DATE
SYM
REVISION RECORD
AUTH.
CK.
A
LOG SENS CH#3
TU
C
26.1K 5K POT
TU
D
LIN AMPL OUT
TU
E
CIR CHGD
TU
TOLERANCES (EXCEPT AS NOTED)
U-D CORP
DECIMAL ±
FRACTIONAL ±
ANGULAR ±
SCALE
DRAWN BY PGM
APPROVED BY
TITLE
I/O BUFFER - LOG METER
B-TF11
DATE
5-28-74
DRAWING NUMBER
B 12064

FIG 8.4

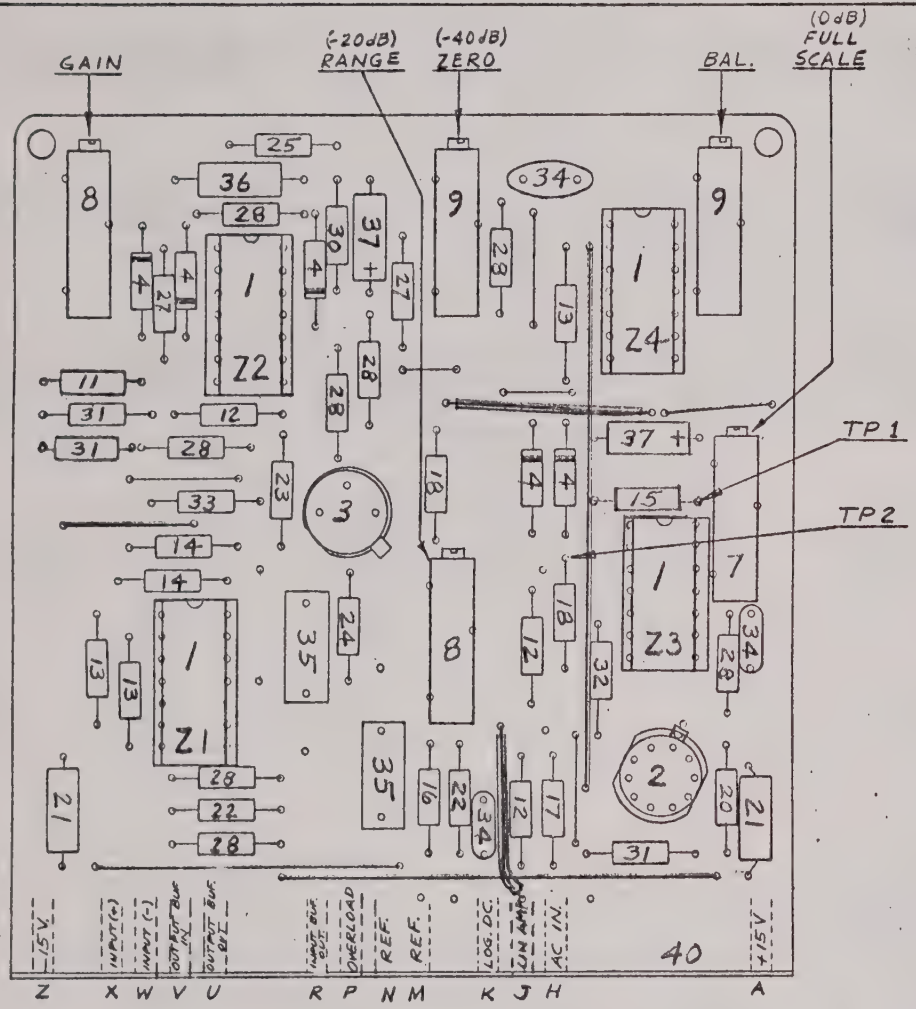


FIG 8.5

REV. E

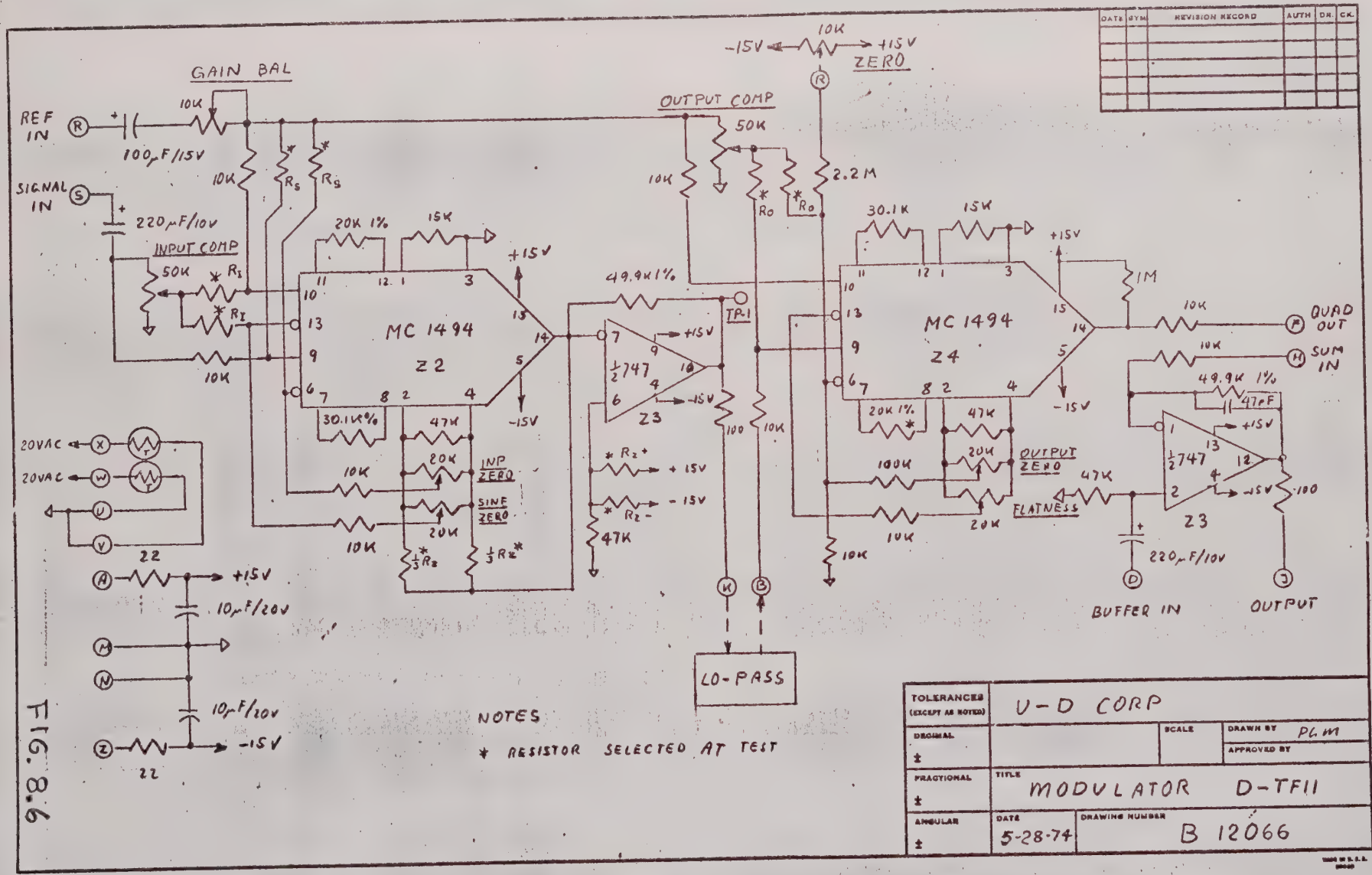
ITEM	QUAN.	DESCRIPTION		ITEM	QUAN.	DESCRIPTION	
1	4	μA747		24	1	330Ω	10% 1/4W
2	1	μA726		25	2	1K	"
3	1	2N699		26	1	1.5K	"
4	5	IN 914		27	2	3.3K	"
5				28	8	10K	"
6				29			
7	1	5K	POT	30	1	3.3K	"
8	2	200Ω	"	31	1	75K	"
9	2	10K	"	32	3	150K	"
10				33	1	100K	"
11	1	909Ω	1% 1/8W	34	3	.01μF/25V	
12	3	10.0K	"	35	2	.1μF/100V	
13	3	20.0K	"	36	1	.47μF/50V	
14	2	274K	"	37	2	10μF/20V	
15	1	26.1K	"	38			
16	1	1.1K	"	39			
17	1	30.1K	"	40		12006-D	
18	2	15.0K	"				
19	1	23.7K	"				
20	1	147K	"				
21	2	22Ω	10% 1/4W				
22	2	47Ω	"				
23	1	100Ω	"				

B-TF11

UNHOLTZ-DICKIE CORP.

COMPONENT LAYOUT
[10 BUFFERS - LOG DC

5/16/75 D12065



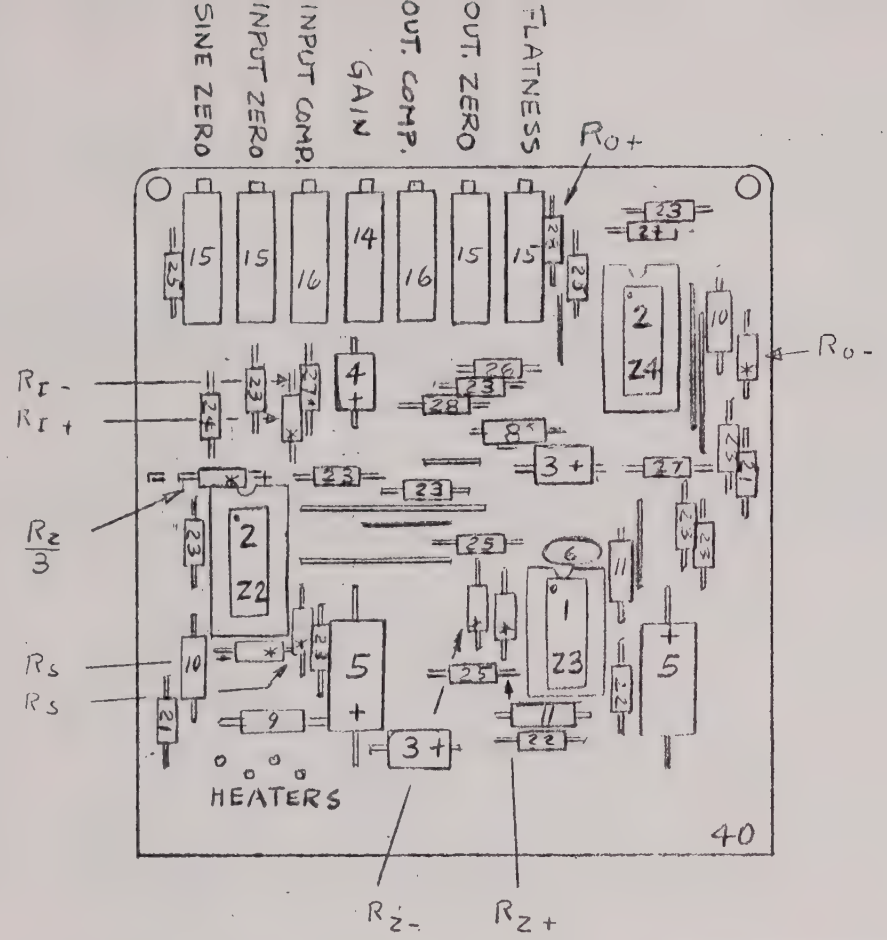
NOTES

* RESISTOR SELECTED AT TEST

DATE	SYM	REVISION RECORD	AUTH	DR.	CK.

TOLERANCES (EXCEPT AS NOTED)	U-D CORP		
DECIMAL ±		SCALE	DRAWN BY PL.M
			APPROVED BY
FRACTIONAL ±	TITLE MODULATOR D-TF11		
ANGULAR ±	DATE 5-28-74	DRAWING NUMBER B 12066	

FIG. 8.6



DATE	SYM	REVISION RECORD	AUTH.	DR.	CK

ITEM	QTY	COMP	ITEM	QTY	COMP
1	1	μA 747	21	2	22 Ω
2	2	NE 1494	22	2	100 Ω
3	2	10μF / 20V	23	10	10K
4	1	100μF / 15V	24	2	15K
5	2	220μF / 10V	25	4	47K
6	1	50pF	26	1	100K
7			27	2	1M
8	1	23.7K 1/8 W	28	2	2.2M
9	1	20.0K 1/8 W			
10	2	30.1K 1/8 W			
11	2	49.9K 1/8 W			
12					
13					
14	1	10K POT			
15	4	20K POT			
16	2	50K POT			
17					
18					
19			*		SELECTED
20			40		12004-D

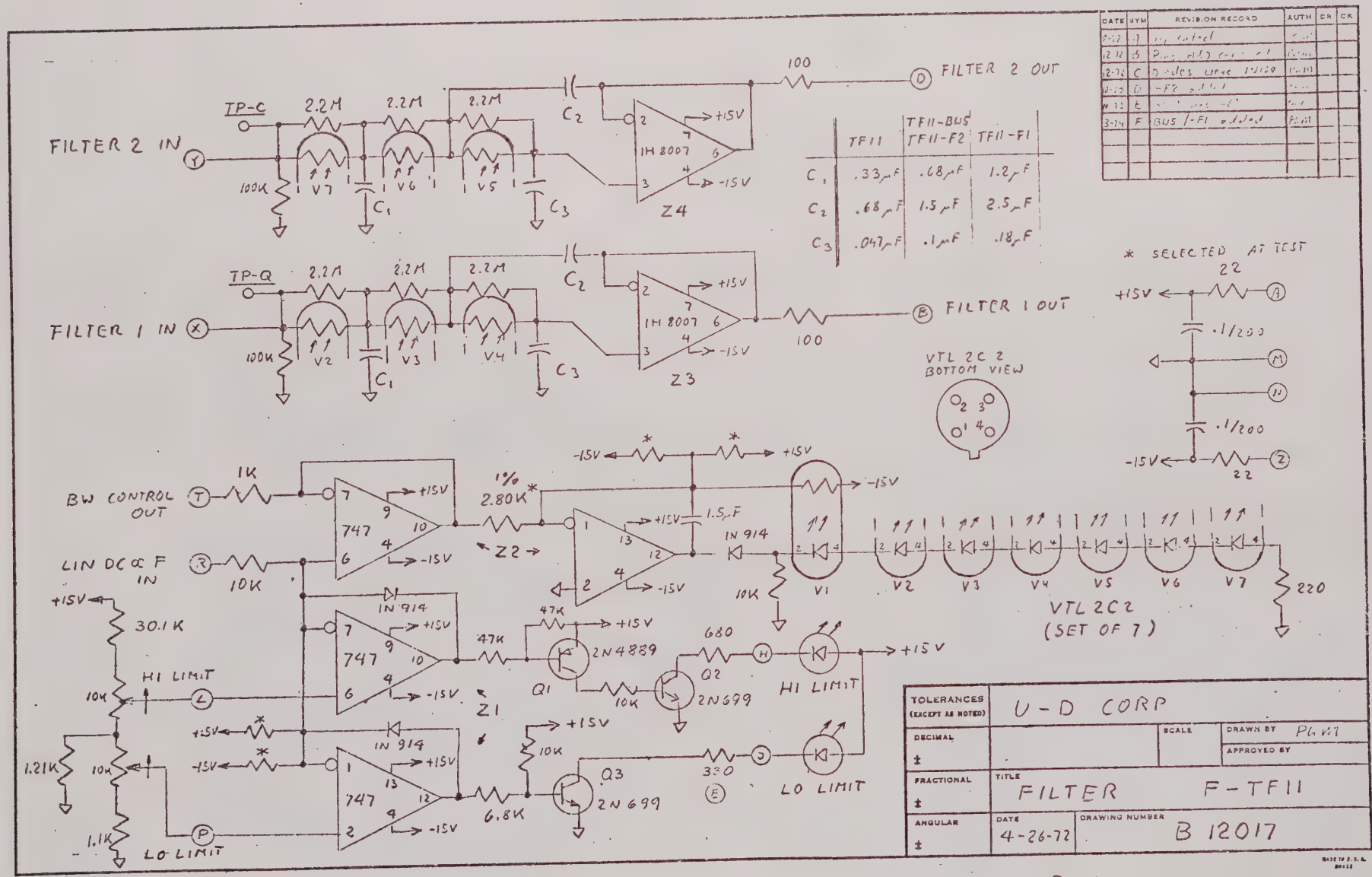
10% 1/4 W

TOLERANCES (EXCEPT AS NOTED)	U-D CORP		
DECIMAL ±		SCALE FULL	DRAWN BY PLM
			APPROVED BY
FRACTIONAL ±	TITLE COMPONENT LAYOUT D-TF11 MODULATOR		
ANGULAR ±	DATE 5-28-74	DRAWING NUMBER A12067	

FIG. 8.7

K+E ALBANENE ⊗ 10 5465 ENGINEERS' STANDARD FORM

MADE IN U.S.A. 46500

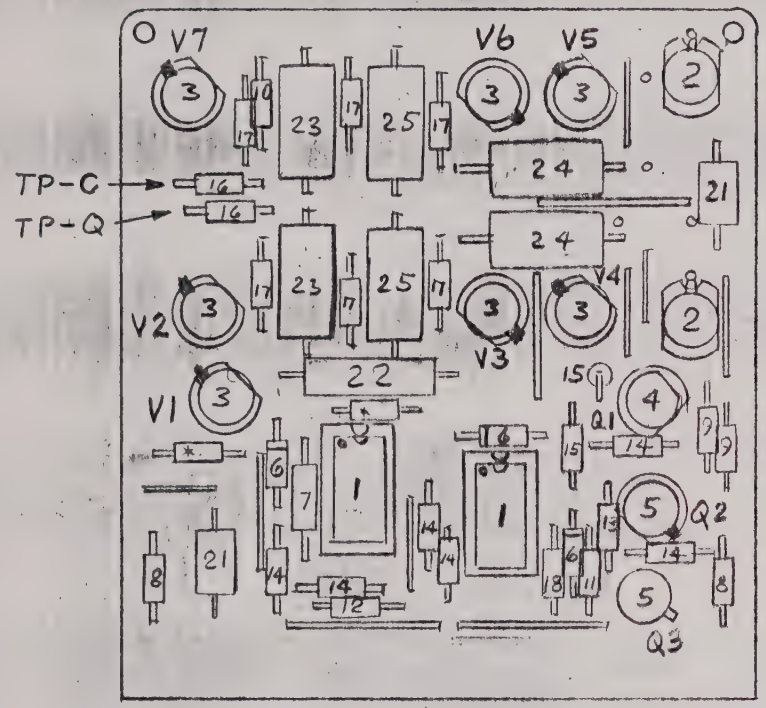


DATE	SYM	REVISION RECORD	AUTH	CH	CK
2-72	A	[illegible]	[illegible]		
12-72	B	[illegible]	[illegible]		
2-73	C	[illegible]	[illegible]		
2-73	D	[illegible]	[illegible]		
2-73	E	[illegible]	[illegible]		
3-74	F	BUS /-F1 added	PLM		

TOLERANCES (EXCEPT AS NOTED)	U-D CORP
DECIMAL ±	SCALE
	DRAWN BY PLM
	APPROVED BY
FRACTIONAL ±	TITLE FILTER F-TF11
ANGULAR ±	DATE 4-26-72
	DRAWING NUMBER B 12017

FIG 8.8

K-E ALBANENE ® 10 5465 ENGINEERS' STANDARD FORM



DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
10-73	A	- F2 added	PGM		
11-73	B	corrected	PGM		
3-74	C	- BW5 1 - F1 added	PGM		

ITEM	QTY	COMP	ITEM	QTY	COMP
1	2	μA747	21	2	.1 μF/80V
2	2	I-8007	22	1	1.5μF/50V
3	7	VTL2C2**	23	2	.33 /50V
4	1	2N4889	24	2	.68 /50V
5	2	2N699	25	2	.047/200V
6	3	IN 914			
7	1	1.74K 1%			
8	2	22Ω			
9	2	47Ω			
10	1	100Ω			
11	2	680Ω			
12	1	1K			
13	1	6.8K			
14	6	10K			
15	2	47K			
16	2	100K			
17	6	2.2M			
18	1	330Ω			
19			*	SELECTED	
20			**	MATCHED SET	

¼ W 10%

ITEM	TF11	TF11-BW5 TF11-F2	TF11-F1	
23	.33	.68	1.2	μF
24	.68	1.5	2.5	
25	.047	.1	.18	

FIG 8.9

TOLERANCES (EXCEPT AS NOTED)	U-D CORP		
DECIMAL ±		SCALE FULL	DRAWN BY PGM
			APPROVED BY
FRACTIONAL ±	TITLE COMPONENT LAYOUT F-TF11 FILTER		
ANGULAR ±	DATE 5-10-73	DRAWING NUMBER A12043	

K+E ALBANENE ® 10 5465 ENGINEERS' STANDARD FORM

MADE IN U.S.A. 22200

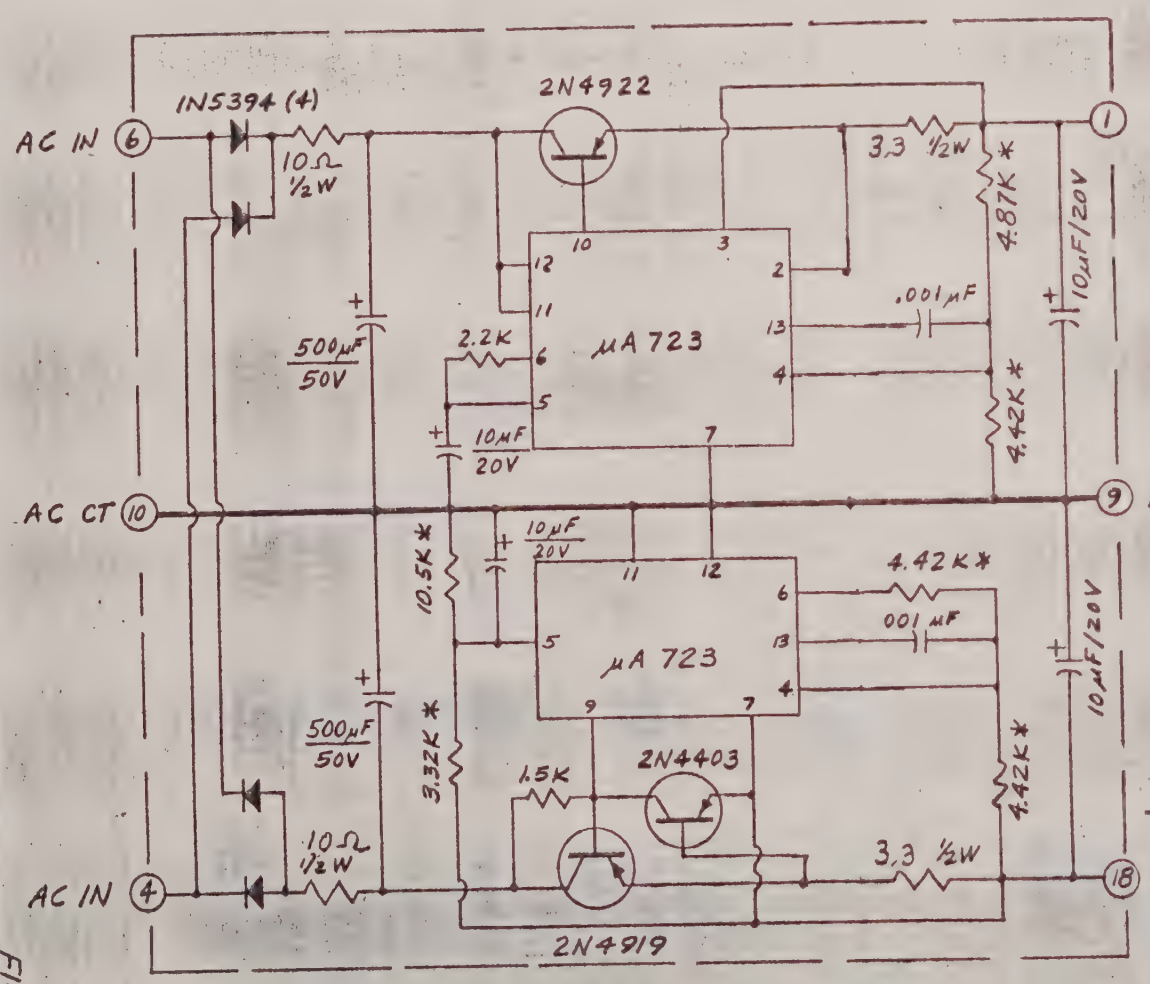


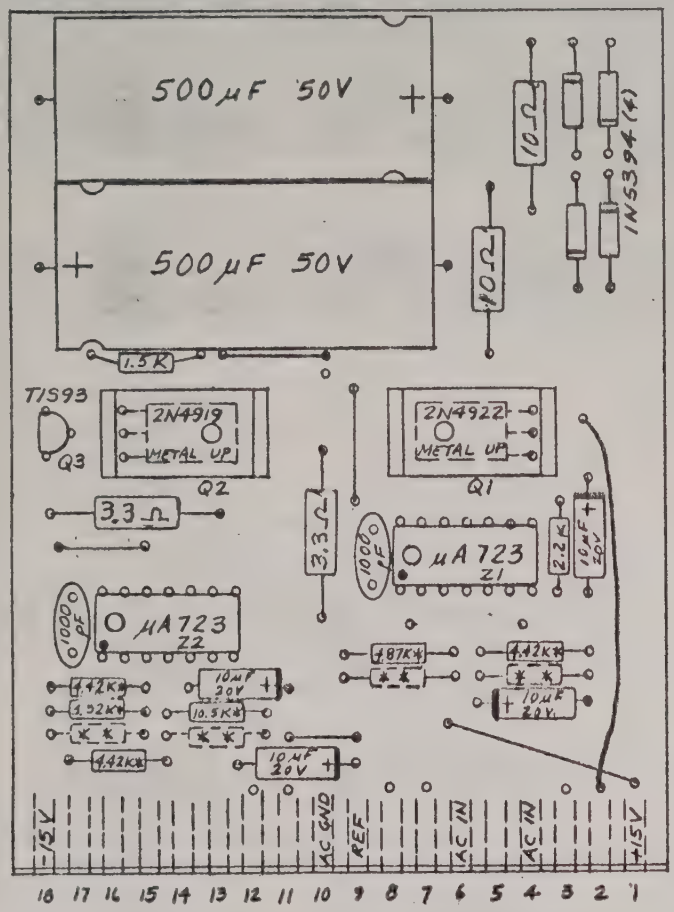
FIG 8.10

DATE	BY	REVISION RECORD	AUTH	DR	CK
		REPLACES B12019	TU		
1/75		NO E.R. LLM			

P-TF11

TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ-DICKIE CORP.		
DECIMAL ±	TF11	SCALE –	DRAWN BY TU / APPROVED BY
FRACTIONAL ±	TITLE CIRCUIT SCHEMATIC POWER SUPPLY CARD		
ANGULAR ±	DATE 12-27-74	DRAWING NUMBER B12080	

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
		REPLACES B12029	TU		
9/15		NO F.B. LIM.			



*- 1% METAL FILM
** FACTORY SELECT

P-TF11

TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ-DICKIE CORP.		
DECIMAL ±	TF11	SCALE 2X	DRAWN BY TU / APPROVED BY
FRACTIONAL ±	TITLE COMPONENT LAYOUT POWER SUPPLY CARD		
ANGULAR ±	DATE 12-27-74	DRAWING NUMBER B12079	

FIG 8.11

K-E

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
7-19	A	TP 1 [illegible]			

MODEL	R (1%)
TFII-L	10K
TFII-LF2	24.9K
TFII-LF1	49.9K

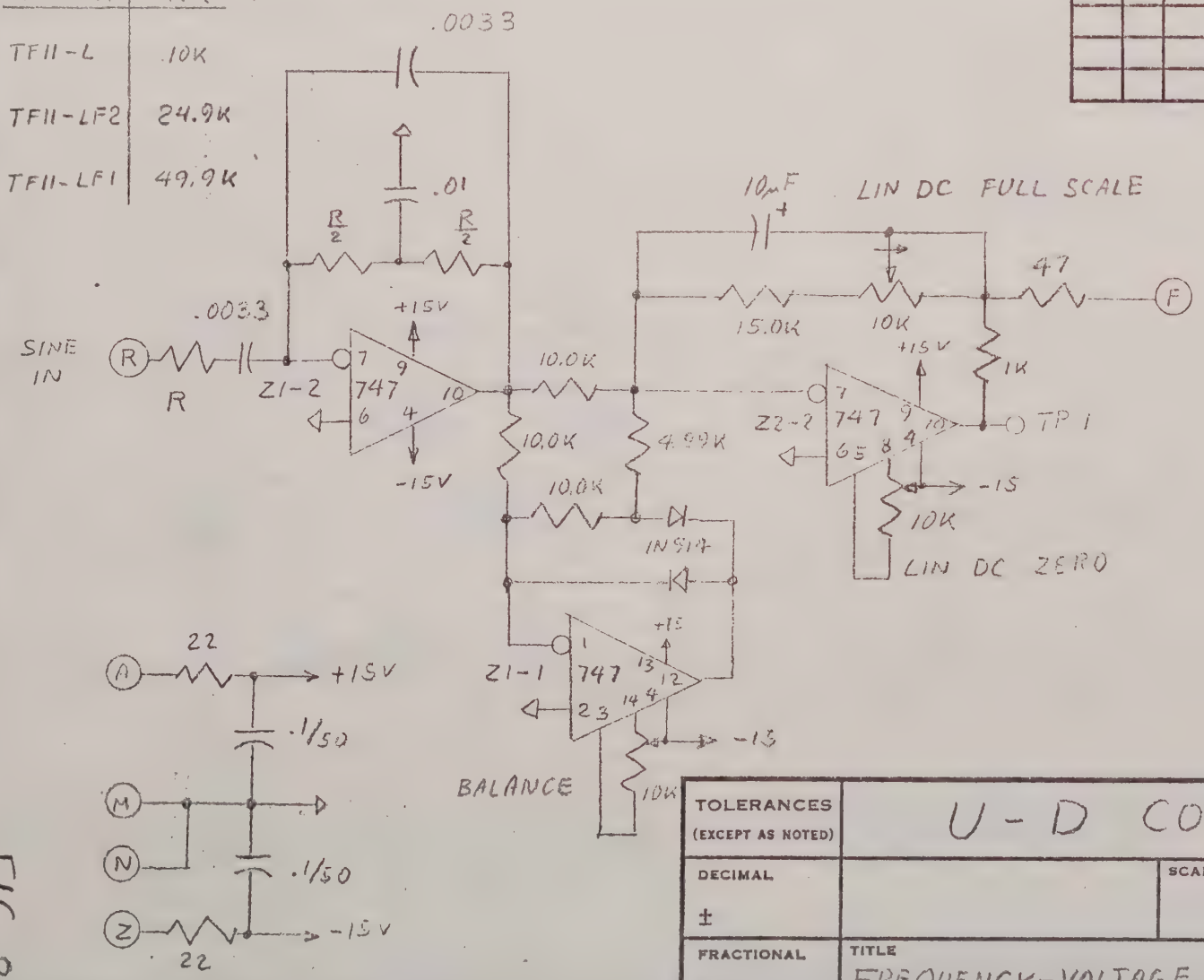
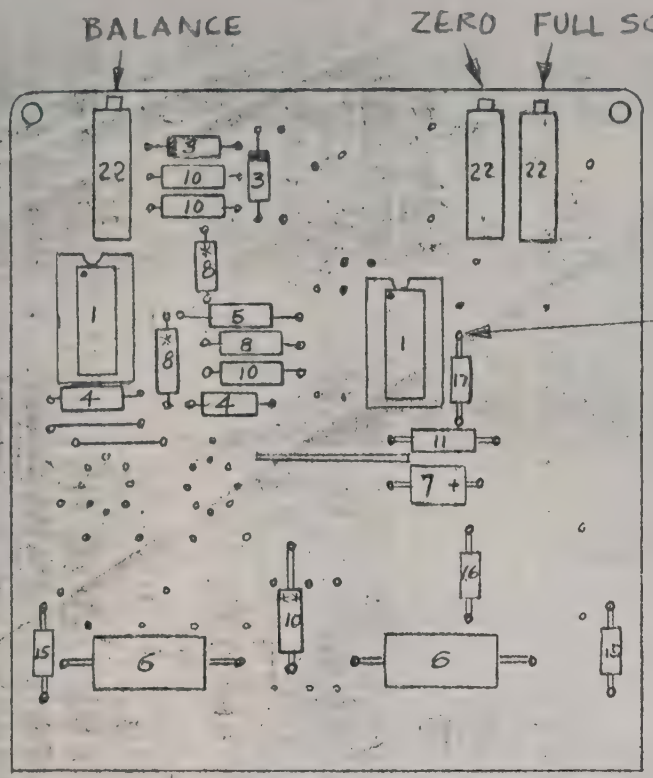


FIG 8.12

TOLERANCES (EXCEPT AS NOTED)	U-D CORP		
DECIMAL ±		SCALE	DRAWN BY Pam
			APPROVED BY
FRACTIONAL ±	TITLE FREQUENCY-VOLTAGE CONV L-TFII		
ANGULAR ±	DATE 9-26-73	DRAWING NUMBER A 12048	



DATE	SYM	REVISION RECORD	AUTH.	DR	CK
10-73	A	-LF2 added	PGM		
4-74	B	CORRECTED	PGM		
3-75	C	LAYOUT CHANGED	TM		

ITEM	QTY	COMP		ITEM	QTY	COMP
1	2	μA 747		21		
2				22	3	10K POT
3	2	IN 914				
4	2	.0033μF/				
5	1	.01μF/200V				
6	2	.1μF/80V				
7	1	10μF/20V				
8	3	4.99K	1% MFF			
9						
10	4	10.0K				
11	1	15.0K				
12						
13						
14						
15	2	22Ω	10% 1/4W			
16	1	47Ω				
17	1	1K				
18						
19						
20						

	TF11	TF11-LF2	TF11-LF1
*	4.99K	12.4K	24.9K
**	10.0K	24.9K	49.9K
	2 mV/Hz	5 mV/Hz	10 mV/Hz

FIG 8.13

TOLERANCES (EXCEPT AS NOTED)	U-D CORP		
DECIMAL ±		SCALE FULL	DRAWN BY PGM / APPROVED BY
FRACTIONAL ±	TITLE COMPONENT LAYOUT L-TF11 LIN DC GENERATOR		
ANGULAR ±	DATE 9-26-73	DRAWING NUMBER A-12028	

K&E ALBANENE ® 10 6465 ENGINEERS' STANDARD FORM
MADE IN U.S.A. 28300

SHORT FORM CATALOG

UDCO

VIBRATION TEST EQUIPMENT

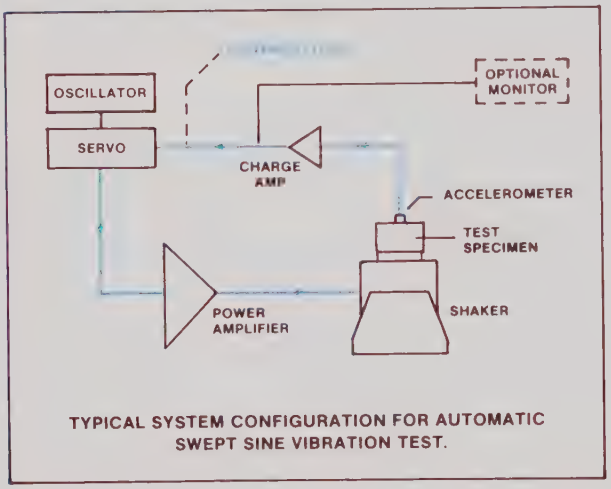
UNHOLTZ-DICKIE CORPORATION

INTRODUCTION

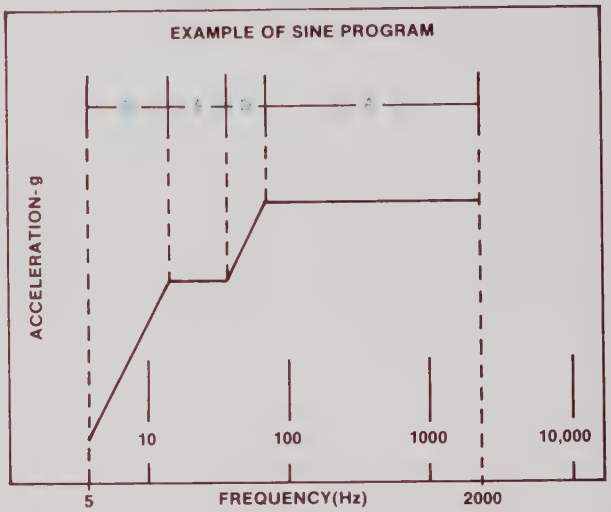
Vibration testing has been a major tool used in the development of military and space hardware for over 25 years. Today, the benefits of vibration testing are being applied in a variety of commercial and consumer product areas as well. This trend parallels an increasing number of federal regulations which require more comprehensive testing to assure product reliability and safety.

Vibration testing can genuinely benefit the manufacturer. By simulating environmental vibration levels during actual product development, the engineer can verify that a design is suitable for its application. This type of testing establishes performance and reliability prior to release of a design for production. Such an approach can save money by minimizing the probability of major redesign work, and even legal liabilities which may result from an inadequate product design. In addition, quality control procedures can be enhanced by using vibration testing as a tool to monitor the consistency of production methods and materials.

Electrodynamic vibration test systems are used to satisfy a wide variety of test requirements. A typical test configuration for swept sine vibration testing is illustrated below (left). This arrangement provides for automatic frequency cycling at preselected vibration levels under servo control. A typical four-level sine test "program" is shown at the right.



TYPICAL SYSTEM CONFIGURATION FOR AUTOMATIC SWEPT SINE VIBRATION TEST.



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• SPECIMEN PROTECTION ACCESSORIES	9
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• CLOSED LOOP WATER COOLING ACCESSORIES	10
• MIL-STD-781C PRODUCTS	11
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VIBRATION TEST SYSTEMS

Unholtz-Dickie produces a wide range of vibration test systems to meet both military and commercial testing requirements. System force ratings from 50 to 40,000 pounds force are available. The table below lists these systems with pertinent technical data.

Every U-D system includes a solid state power amplifier and features reliable air cooling of the shaker armature. Systems engineering of each system component assures maximum performance with simplified operation.

SHAKER MODEL/ SERIES	SYSTEM PERFORMANCE				SHAKER DATA			
	FORCE, lbs.		STROKE inches DA	MAX. SINE PAYLOAD AT 20g	ARMATURE WEIGHT, lbs.	TABLE DIA., inches	FREE TABLE f_n	SUSPENSION STIFFNESS lbs./inch
	SINE pk	RANDOM rms						
5PM	50		0.5	1.8	0.7	2	8,000	60
1(1)	50		1	1.9	0.55	drive rod	5,500	0
20	120	60	1	3	3	3.5	3,300	225
4(1)	150		4	5.2	2.25	drive rod	3,000	0
4C(1)	250		4	9	3.5	drive rod	2,400	0
20	250	125	1	9.5	3	3.5	3,300	225
20	300	185	1	12	3	3.5	3,300	225
T102	500	300	1	19.7	5.3	4.5	4,300	225
6(1)	1,000		6	39	11	drive rod	1,800	0
200 SERIES	1,200	600	1	40	20	8	3,100	600
	1,700	850	1	65	20	8	3,100	600
	3,000	2,200	1	134	16	8		300
	3,000	2,200	1	128	22	8	3,100	600
	3,000(2)		0.5		31*	8	5,800	600
	4,000	3,300	1	171	29	8	2,700	600
RTS-5	CONSULT FACTORY (see page 11)							
500 SERIES	6,000	3,000	1	264	36	12	2,800	1,200
	6,000	4,500	1	264	36	12	2,800	1,200
	7,000	4,000	1	300	50	12	2,400	1,200
	7,000	5,500	1	300	50	12	2,400	1,200
1000 SERIES	8,000	4,000	1	310	90	16	2,300	3,000
	10,000	5,000	1	410	90	16	2,300	3,000
	12,000	6,000	1	510	90	16	2,300	3,000
	12,000	7,500	0.7(3)	505	95*	16	2,300	3,000
	15,000	9,500	0.75(3)	655	95*	16	2,300	3,000
	16,000	11,500	1	705	95*	16	2,300	3,000
	17,000	9,500	1	755	95*	16	2,300	3,000
	17,500	14,000	1	780	95*	16	2,300	3,000
	17,500	16,000	1	780	95*	16	2,300	3,000
	19,000	15,000	1	855	95*	16	2,300	3,000
	19,000	17,500	1	855	95*	16	2,300	3,000
	24,000	20,000	1	1,105	95*	16	2,300	3,000
4000 SERIES	19,000	16,000	0.5	710	240*	24	1,800	4,000
	30,000	23,000	0.5	1,260	240*	24	1,800	4,000
	36,000	33,000	1	1,560	240*	24	1,800	4,000
	40,000	30,000	1	1,760	240*	24	1,800	4,000
	40,000	37,000	1	1,760	240*	24	1,800	4,000

NOTES: * Induct-A-Ring (IAR) armature
(1) Modal shaker
(2) Special high freq. IAR design
(3) 1 inch stroke with reduced force rating

SHAKERS

Unholtz-Dickie manufactures a wide variety of general purpose and special application shakers, covering the force range from 50 to 40,000 pounds as illustrated on the following pages.

Model 5PM

Max Output:
50 lbs pk force
0.5 inch pk-pk stroke

Cooling:
Air

Armature Type:
Wound Coil

Body Dia:
8 - 7/16"

Model 20

Max Output:
300 lbs pk force
1 inch pk-pk stroke

Cooling:
Air

Armature Type:
Wound Coil

Body Dia:
11 - 3/4"

Model T102

Max Output:
500 lbs pk force
1 inch pk-pk stroke

Cooling:
Air/Water

Armature Type:
Wound Coil

Body Dia:
17"

200 Series

Max Output:
4000 lbs pk force
1 inch pk-pk stroke

Cooling:
Air

Armature Type:
Wound Coil

Body Dia:
27 - 1/2"

SHAKERS

All U-D shakers utilize **air cooled armatures** for maximum reliability. Many models are available with the unique INDUCT-A-RING armature, further described on page 6.

500 Series

Max Output:
7000 lbs pk force
1 inch pk-pk stroke

Cooling:
Air

Armature Type:
Wound Coil

Body Dia:
35″

1000 Series

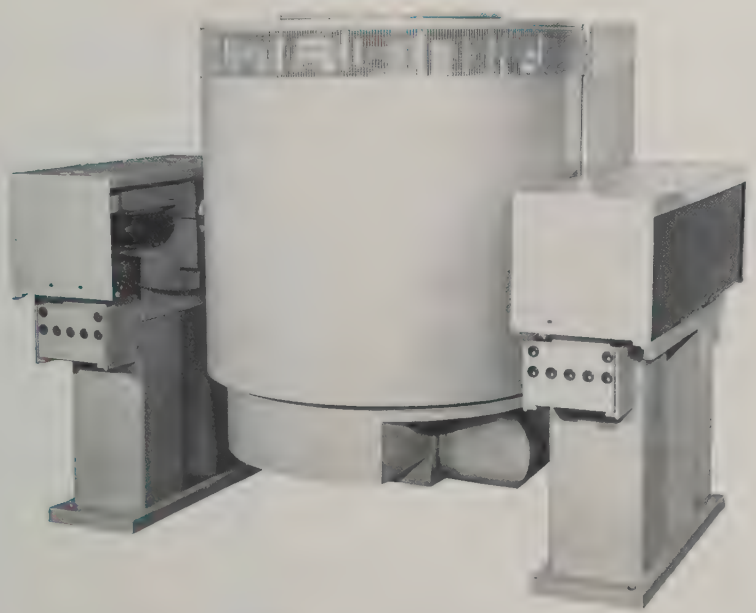
Max Output:
24,000 lbs pk force
1 inch pk-pk stroke

Cooling:
Air/Water

Armature Type:
Wound Coil (to 12,000 lbs)
INDUCT-A-RING (to 24,000 lbs)

Body Dia:
35″

4000 Series



Max Output:
40,000 lbs pk force
1 inch pk-pk stroke

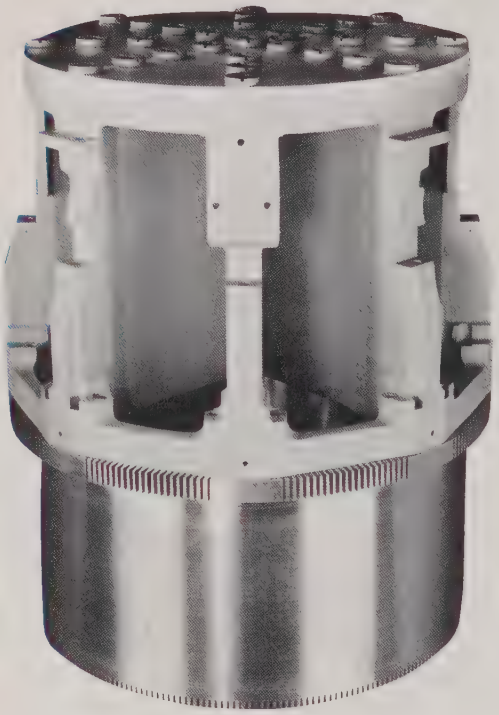
Armature Type:
INDUCT-A-RING

Cooling:
Air/Water

Body Dia:
44″

INDUCT-A-RING ARMATURE

INDUCT-A-RING is the U-D trade name for a revolutionary armature design concept. The principle of transformer action is utilized to transfer energy from stationary AC driver coils (stators) to the armature.



- The moving element is a simple two-piece metal structure. A single turn, solid metal cylinder is bolted directly to the shaker table casting, providing the ultimate in strength and rigidity.
- All points on the vibrating member are at ground potential (zero voltage) at all times. There are no electrical windings with epoxy bonded joints. There is no possibility of voltage breakdown, and therefore no insulation is required.
- The solid metal, single turn ring is air cooled. Cooling connections subject to armature vibration are eliminated.
- AC currents are induced into the solid metal ring, eliminating electrical connections which bridge stationary and moving parts.

The INDUCT-A-RING armature is featured in 1000IAR SERIES and 4000 SERIES shakers, rated up to 24,000 lbs force and 40,000 lbs force, respectively. A special high frequency 3000 lbs force configuration is also available, see below.

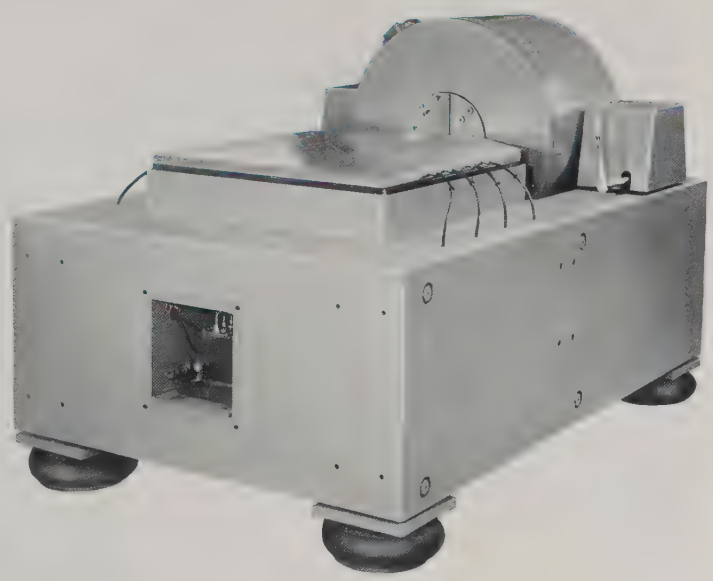
HIGH FREQUENCY 208IAR

The Model 208IAR Shaker rated at 3000 pounds force utilizes a special "Induct-A-Ring" armature consisting of a one-piece continuous aluminum casting with an integral single-turn cylinder acting as the force generating coil (illustrated at the right). The 9¼ inch diameter table has an unloaded resonant frequency of 5,800 Hz making the 208IAR Shaker an excellent high frequency machine for use in testing turbine blades, engine accessories and related items. See above for additional discussion of the Induct-A-Ring concept.

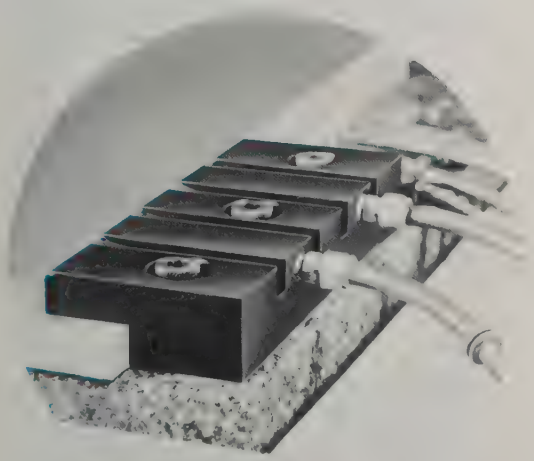
PERMALINE

Combined Slip Table Assembly

The PERMALINE Combined Slip Table Assembly allows testing in three mutually perpendicular axes while using only one basic test fixture. Permanent factory alignment of the shaker and slip table provides quick changeover from vertical to horizontal operation. Inflatable air mounts effectively isolate the entire assembly from the supporting structure, thereby eliminating the need for special floor construction.



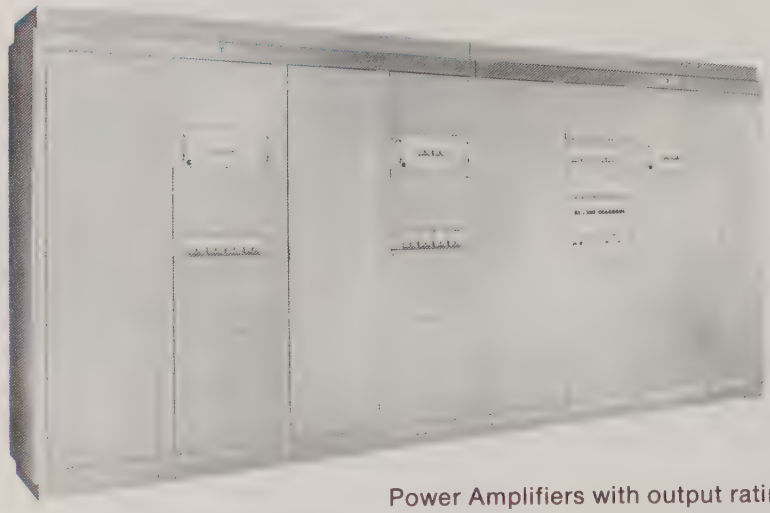
- Heavy loads may be vibrated horizontally without external support.
- Factory alignment of the shaker and slip table is maintained by the rigid common base.
- The massive base is deep sectioned throughout its entire length, minimizing bending vibration responses.
- An oil recirculation system is provided with multi-cylinder, constant flow pumps to assure uniform oil distribution over the complete bearing surface.
- Conversion to horizontal operation is provided by a manual gear drive, allowing easy rotation of the shaker.
- The entire assembly is isolated from the floor by the heavy seismic mass supported on air mounts.
- The CSTA requires no special floor construction, and may be moved from one area to another by a suitable forklift.



OPTIONAL 4HD BEARINGS

For large package testing applications where substantial over-turning moments are generated, optional hydraulic restraints are available to restrict lateral and vertical slip plate motion. One bearing is located at each corner of the slip plate, providing restraint at four widely spaced locations across the plate. Separate, constant-flow oil lines supply lubricant to the vertical and horizontal bearing surfaces in each of the four restraints, as shown at left.

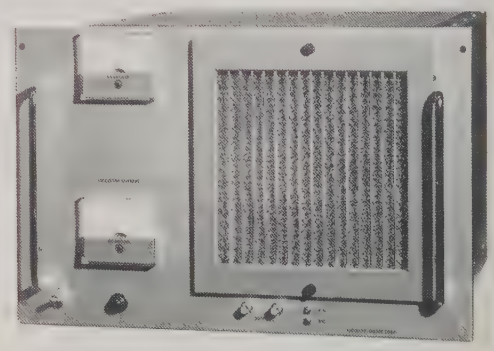
SOLID STATE
Power Amplifiers



U-D pioneered the use of large solid state power amplifiers to drive electrodynamic shakers in the early 1960's. Advances in silicon technology have been combined with proven circuit designs to produce the present generation of amplifiers. This design has demonstrated reliable performance in hundreds of customers installations since its introduction in 1968. Over eleven years of field proven reliability stand behind every U-D solid state power amplifier - a record unmatched in the industry.

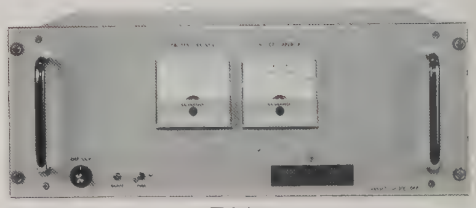
Power Amplifiers with output ratings from 16 kVA to 256 kVA utilize a water cooled, modular output stage design with premium grade, silicon alloy junction transistors. Output transistors are stud mounted in massive water cooled heat sinks. All output transistor terminals are physically accessible, permitting routine maintenance checks during actual amplifier operation without draining of heat sink coolant and without the use of extender cards.

A number of lower force U-D shaker systems include the Model TA100A or Model TA250A Power Amplifiers rated at 1.5 kVA and 2.5 kVA, respectively. These models utilize the same basic circuitry as their water cooled counterparts except that output heat sinks are air cooled by an internal fan. Both the TA100A and TA250A are constructed in a rack mount chassis as illustrated at the right. An optional "current feedback" feature is available for "modal" testing to provide constant force operation (see page 12).

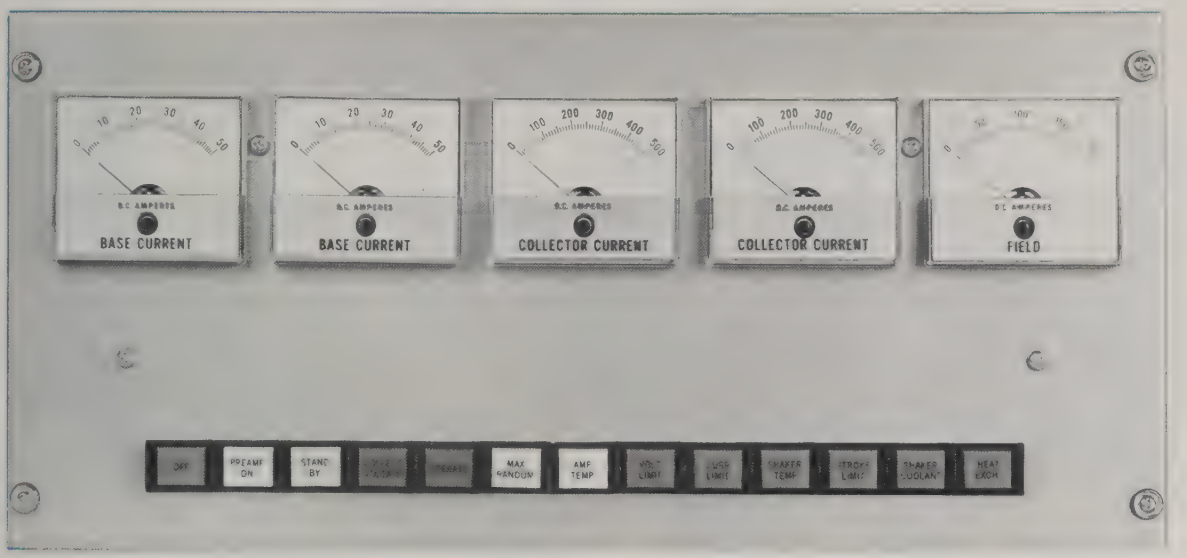


The Model TA30 and Model TA35 Power Amplifiers are air cooled, rack mount configurations rated at 250 VA each. The TA30 is typically used to drive the Model 5PM or Model 20 Shaker for general purpose testing. The TA35 typically is used to drive the Model 1 Shaker for "modal" testing applications (see page 12).

TA30



TA35



System Control Panel (Typical)

System pushbutton operating controls, output meters and diagnostic lights are consolidated on a central control panel which typically is located in the Power Amplifier console. An optional remote control panel is available to permit installation of duplicate system controls in a control console remote from the Power Amplifier.

SRP-3 SPECIMEN PROTECTION

The Model SRP-3 SINE-RANDOM SPECIMEN PROTECTION SYSTEM incorporates a comprehensive, systems-integrated methodology (1) to provide an effective means of placing adjustable limits on the output capability of a high performance shaker system, and (2) to minimize potentially destructive acceleration transients which might otherwise be generated during conventional system shutdowns.

DIGITAL CONTROLS INTERFACE

U-D guarantees the interface of its shaker systems with any digital control system. This guarantee assures our customers of complete flexibility to select the digital control configuration best suited for their requirements, without concern for interface compatibility.

U-D also offers interface accessories to permit microprocessor control of system operating modes, multiple shaker switching and other functions which may be sequenced automatically for unattended operation.

SOLID STATE POWER AMPLIFIERS FOR EXISTING SHAKERS

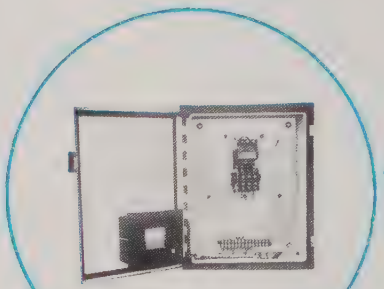
C10	C60
C20	C90
C21	C126
C30	C150
C50	C210
C220	

330	275
246	275A
300	335
A249	

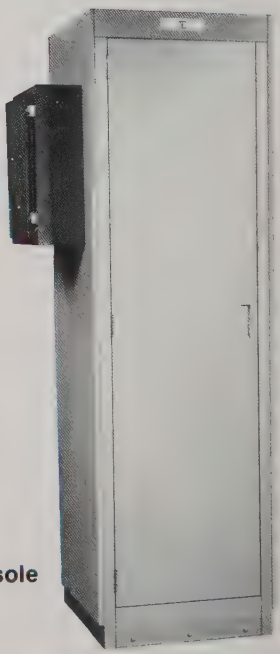
U-D offers a complete family of Solid State Power Amplifiers to replace high voltage vacuum tube P.A.'s in most older shaker systems as indicated on the right. Contact our factory for recommendations concerning your specific shaker model.

CLOSED LOOP WATER COOLING ACCESSORIES

For those U-D Vibration Test Systems which require water cooling of the Power Amplifier and/or Shaker, complete closed-loop cooling consoles are available as illustrated on the right. The console, constructed in an attractive paneled enclosure, includes all the required heat exchanger hardware, pumps, filters, deionizers, conductivity monitoring and complete interlock wiring to assure fully systems-engineered operation.



NEMA 12 Enclosure



Separate Cooling Console (typical)

Exposure of maintenance personnel to electrical shock hazard is minimized by the use of water tight conduits to remove all electrical terminations from console areas where water connections are located. Access to input power connections, control wiring and water conductivity monitor is provided within a NEMA 12 enclosure, as illustrated.

MIL-STD-781C PRODUCTS

In addition to a broad range of general purpose and special application systems, U-D also offers systems dedicated to MIL-STD-781C vibration requirements. The Model RTS-5 Shaker, pictured at the right, is a rugged all air cooled shaker conservatively designed for extended periods of reliability testing. The RTS-5 utilizes the electrodynamic design principle, substantially extending the available operating frequency range beyond that of mechanical or hydraulic shakers. System ratings up to 5000 lbs rms random force with full one inch stroke are available.

VERTICAL OR HORIZONTAL OPERATION

The RTS-5 Shaker is directly adaptable for vertical operation utilizing a large 31½ inch diameter table, or for horizontal operation utilizing a unique two piece self-aligning horizontal slip table assembly. Two armature sizes are available: a 31½ inch dia table provides maximum mounting area for vertical tests, and a 17½ inch dia table is used for horizontal slip table operation where large table size is not necessary. The 17½ inch table also provides improved high frequency response for vertical test applications where dynamic considerations favor a smaller table.

Typical AGREE Chamber

RTS-5 Shaker (vertical mode)

AGREE CHAMBER COMPATIBILITY

RTS-5 interface accessories assure direct compatibility with new or existing AGREE chambers for vertical and horizontal operation. "Air-Glide" elements in the RTS-5 base develop a frictionless cushion of air allowing effortless positioning of the shaker relative to the chamber enclosure. After final positioning of the shaker and/or slip table, integral air mount isolators can be activated to provide effective vibration isolation.

CONTROL ACCESSORIES

The Model SG-36 Spectrum Generator provides the drive signal to the power amplifier for random testing, utilizing a noise generator source and 36 equalizing filters. Each filter has an adjustable gain control which in combination cover the frequency range from 10 Hz to 2000 Hz. The SG-36 is used in "open loop" to manually shape the acceleration PSD versus frequency profile. An internal compressor circuit provides transient-free initiation and termination of the vibration test.

The Model A-36 Spectrum Analyzer has 36 filters which analyze the accelerometer response signal and drive a CRT display showing the complete 10-2000 Hz spectrum. A true rms digital meter indicates the overall g rms level including adjustable HIGH/LOW test limits which automatically trigger the SG-36 compressor if the test level does not remain within the selected "window." Simple pushbutton controls permit initiation and termination of the test. Capability for remote sequencing by a chamber microprocessor is provided.

SINE CONTROLS

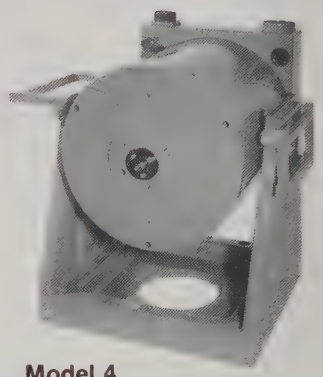
Automatic controls for swept sine vibration tests are also available, as summarized on page 13.

MODAL SHAKER SYSTEMS

Unholtz-Dickie manufactures a family of shakers designed specifically for "modal" testing. These shakers feature long stroke, low internal damping, and near zero axial spring rate. These special characteristics facilitate the excitation of pure structural modes, especially when multiple shaker arrays are utilized. The shaker moving element includes a hardened output shaft for connection to the test object.

These modal shakers incorporate a double ended field structure, providing parallel flux paths from above and below the magnetic air gap. This design gives maximum magnetic flux linkage with the armature coil, and assures optimum waveform purity. Uniform flux density throughout the operating stroke provides output force proportional to armature current, independent of armature position.

When driving power is provided by a U-D solid state power amplifier with "current feedback," these shakers can be operated as **constant force** generators. In this operating mode, shaker armature current is proportional to power amplifier input voltage through large variations of load impedance; therefore, the magnitude of the generated AC force in the armature coil remains constant as a function of frequency. This constant force characteristic also requires the shaker to have a "force/armature current" ratio reasonably independent of armature position, as described earlier. Constant force sweeps can be performed without force links, external servos, or tracking filters.



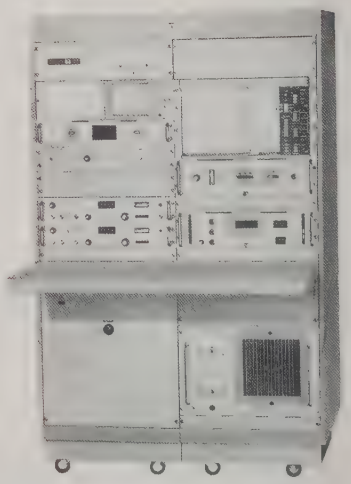
Model 4

Three basic models are available. The Model 1 is a 50 pound force, permanent magnet design with a one inch stroke. The Model 4 is a four inch stroke shaker rated up to 250 pounds force. Both of these units feature folding-type carrying handles which enhance portability.

The Model 6 Shaker generates up to 1000 pounds force and provides a full six inch stroke. This shaker is frequently used to generate low frequency motion in seismic simulation studies, or for vehicular studies in aerospace applications.

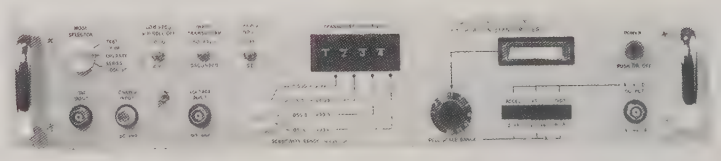
SERIES 300 VIBRATION TRANSDUCER CALIBRATION SYSTEMS

The Series 300 Calibration Systems are offered with manual controls for point by point calibration, or with frequency sweeping controls giving an automatically drawn curve of % deviation of the "unknown" transducer sensitivity relative to the "reference" accelerometer, as a function of frequency. Original data is permanently plotted, eliminating operator errors in readout and transcription.



Model 351 System

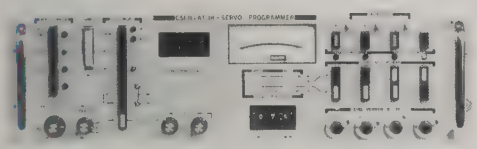
At full system performance, and with automatic servo controls operating, acceleration waveform distortion is less than 1.5% at all operating frequencies. The overall system noise level is less than .005 g rms. Automatic plotting systems feature 0.25% plotting resolution of the unknown transducer output relative to the reference.



The Model 1611 Precision Charge/Voltage Calibration Standardizer is supplied in 300 Series Calibration Systems to provide stable, high accuracy comparison calibrations. Typical overall instrument accuracy and stability is ¼%, with flat response from 2 to 20,000 Hz.

AUTOMATIC SINE CONTROLS

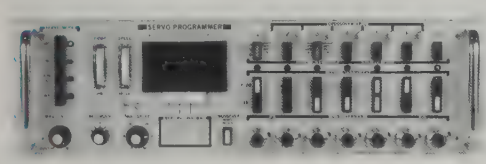
U-D manufactures a variety of general purpose and specialized automatic sine control systems, including the two popular configurations shown below. Both of these control systems feature a **zero static error servo**, permitting large gain changes in the compressor (AGC) circuitry without introducing static errors in the actual control level.



The **OSP-4 Oscillator-Servo-Programmer** is our most economical, compact sine control system. This unit combines the following features in a single chassis: a sweeping digital sine generator, frequency counter, vibration meter, servo control, four-level programmer, and input charge amplifier. Frequency range: 5 to 5,000 Hz.

The most comprehensive sine control system available in the industry consists of the **OSC-1S Sweep Sine Generator** and **SPA-7 Servo Programmer.**

The OSC-1S is a sweeping digital sine generator which operates from 2 to 5,000 Hz. A built-in digital frequency counter reads and displays ten times per second even at 2 Hz. Sweep rate and number of sweeps may be preselected to provide automatic test shutdown. A sawtooth generator output permits synchronous scope display of the vibration waveform.

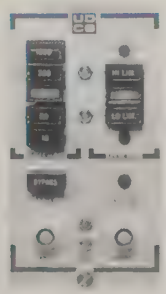


The SPA-7 is a programmable seven-level servo. Digital display of acceleration, velocity or displacement is provided, plus automatic or manual modes for selecting the crossover frequency between program segments. An input charge amplifier is standard.

ENGINE TEST CELL MONITORING

The Model ATF-4A Auto-Tuned Filter is designed to measure narrowband and wideband vibration components in a variety of engine test cell applications including aircraft turbofans and other engines. The ATF-4A is a four channel instrument, each channel containing two automatically tuned constant percentage bandwidth filters. Each data channel accepts a conditioned velocity signal such as from the U-D Model 1612Charge Amplifier and provides DC outputs proportional to the two narrowband vibration levels. The wideband level also may be selected. The center frequencies of the two narrowband filters are controlled by conventional tachometer signals from the engine (N1 and N2), and the tachometer frequency ratios are widely adjustable from the front panel.

TRACKING FILTERS

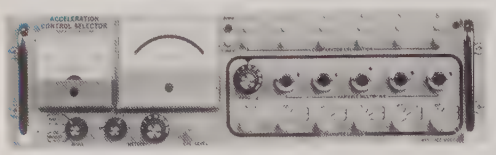


The Model TF22 Tracking Filter is a unity gain, constant percentage bandwidth filter featuring stable integrated circuit design. The filter bandwidth varies between 2 and 200 Hz as defined by 10% of the tuning frequency. Fixed bandwidth operation also is selectable.

The TF22 typically is used to filter noise and harmonic distortion from the control signal in swept sine vibration tests. A log DC signal proportional to the filtered AC output is provided, facilitating mechanical impedance measurements and transfer function analysis. Six TF22 modules can be mounted in a 5¼ x 19 inch rack space.

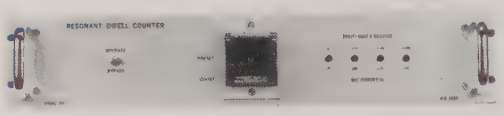
CONTROL ACCESSORIES

Model MAC-8 Multifunction Averaging Control accepts up to eight 10 mV/g signals for controlling to the average signal level. Can be used for sine or random vibration testing.



Model ACS-6 Acceleration Control Selector automatically selects for feedback control the highest (or lowest) acceleration input from up to six 10 mV/g sine acceleration signals, by gating to the output whichever signal reaches its preset amplitude limit.

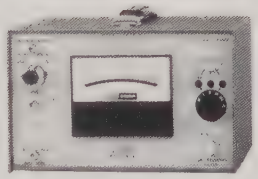
Model RD-1 Resonant Dwell Control automatically maintains the vibration testing frequency at the resonant frequency of a test specimen during fatigue testing.



Model RD-2 Resonant Dwell Counter indicates the number of stress cycles accumulated by a specimen undergoing a resonant dwell test. Counter may be preset to initiate automatic shutdown after completion of desired number of stress cycles.

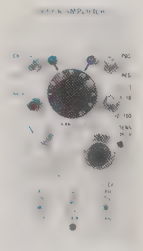
Model AM-123 Vibration Monitor/Limiter provides overtest protection for vibration test specimens, utilizing adjustable, simultaneously active shutdown limits for both acceleration and displacement. Protection circuits operate for sine or random testing and provide soft, rapid shutdown.

VIBRATION MONITORING ACCESSORIES



Model 1610M Portable Vibration Monitor can be used to condition piezoelectric accelerometers with 0.5 to 100 pC/g sensitivity. Monitors acceleration, velocity, or displacement with log scale meter readout and switch selectable outputs. Also available in single and dual channel rack mount versions (1610RM, 2610RM).

Model 322 Signal Conditioner consists of three charge amplifier channels with separate power supplies for basic, simplified operation with piezoelectric accelerometers, two-wire remote preamps, or two-wire industrial accelerometers. A 1 volt full scale output is provided for each channel for direct tape recording.



Model SA22 Shock Charge Amplifier measures shock pulse durations from 100 microseconds to 500 milliseconds and pulse amplitudes up to 100,000 pC peak. Intended for use with customer-supplied storage scope and camera.

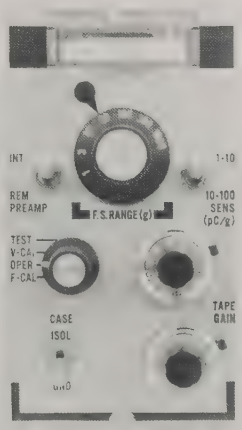
Model 2216 Signal Conditioner is a low cost, modular instrument for use with the Model 100PA or 1000PA Accelerometers. Permits acceleration measurements down to 0.1 Hz with less than 30 micro "g" residual noise with the Model 1000PA or measurements down to 0.5 Hz with less than 50 micro "g" residual noise with the Model 100PA.

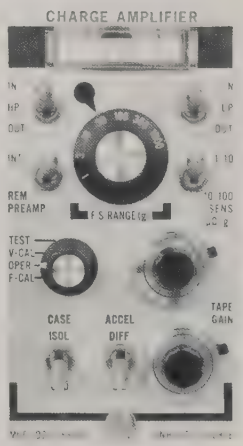
D22 SERIES SIGNAL CONDITIONERS

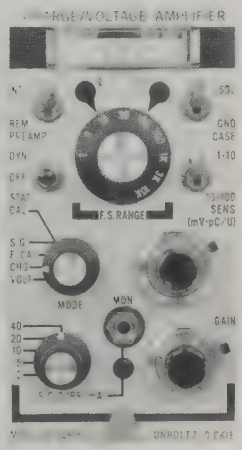
D22 Series Signal Conditioners feature integrated circuit design with superior low noise operation, DIAL-A-GAIN input sensitivity adjustment and rugged, modular construction. Four basic models are offered: D22PM, D22PMH, D22PMR, and D22PMB as illustrated below. A variety of optional features are available to satisfy most types of data acquisition requirements.

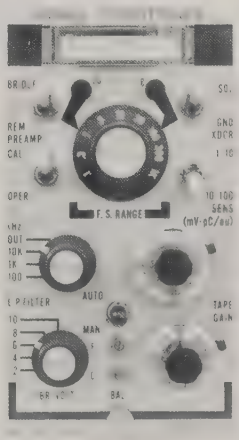
D22PM:
Accepts inputs from single-ended piezoelectric accelerometers (0.5-100 pC/g) or can be used with 22CA-2 Remote Preamps. Includes output meter, adjustable 0-10 V pk full scale output, isolate/ground feature for rejection of ground loop pickup, and 3 calibration modes.

D22PMR:
Accepts inputs from single-ended piezoelectric accelerometers (0.5-100 pC/g) and single-ended strain gages (for dynamic measurements), high impedance voltage sources, or can be used with 22CA-2 Remote Preamps. Includes calibrated constant current strain gage supply, output meter, adjustable 0-1 V pk full scale output, isolate/ground feature for rejection of ground loop pickup, and 2 dynamic calibration modes.







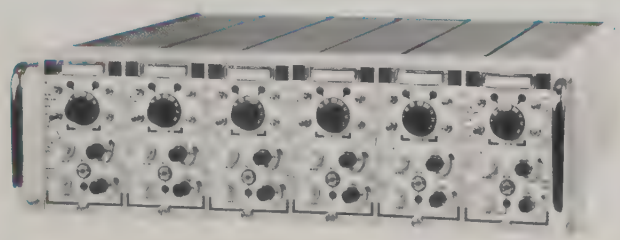


D22PMH:
Accepts inputs from single-ended and differential (high temp) piezoelectric accelerometers (0.5-100 pC/g) or can be used with 22CA-2 Remote Preamps. Includes switch selectable Low Pass and High Pass filters, output meter, adjustable 0-10 V pk full scale output, isolate/ground feature for rejection of ground loop pickup, and 3 calibration modes.

D22PMB:
Accepts differential inputs from 1, 2 or 4 arm bridges (for dynamic or DC strain measurements) and piezoresistive accelerometers, or can be used with 22CA-2 Remote Preamps. Includes selectable precision bridge power supplies, selectable Low Pass filter, auto balance feature, output meter, 0-10 V pk full scale output, and isolate/ground feature.

D22 OPTIONS

DESCRIPTION	SUFFIX
10 mV/g servo output	S
100 mV-sec/in velocity output	I
1 V/in displacement (DA) output	II
Linear DC output, 10 V F.S.	F
Log DC output, 1V/decade	L
±100 mA galvo output	G
±100 mA line driver (boosts tape output)	C
Internal cal. oscillator	O
Tracking filter interconnection	T
0.5 Hz frequency response	-2
Extra X10 gain	-3
Remote relay cal.	-4
Large 2½" scale meter	-8
External range control	E
Auto ranging	A



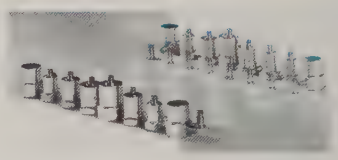
Model 22RA Rack Adapter accepts six D22 Series modules with standard 5¼ inch panel height. Also accepts six TF22 Tracking Filter modules (see page 13).

Models D22PM, D22PMH and D22PMR are available with the "-8" option which provides a 2½ inch scale meter for easier readout. A special 8¾" high rack adapter (22RA-8) is available for rack mounting -8 type modules.

The Model 22CA-2 Remote Charge Preamp may be used with any of the D22 Series instruments shown above and is a companion unit to the Model P22MS at left, which operates exclusively with the remote charge preamp.

ACCELEROMETERS

A full line of self-generating piezoelectric accelerometers are manufactured by Unholtz-Dickie for general purpose vibration testing and for many special measurement requirements. Various models are optimized to provide features such as subminiature size, high output sensitivity, and high temperature operation.



10B10 and 10B10T:

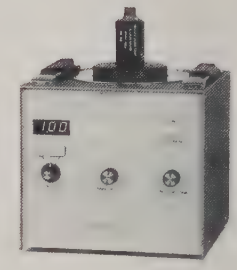
These two models have a factory adjusted sensitivity of 10 pC/g. This normalized output feature permits the interchange of accelerometers among many channels of charge amps without concern for changing input sensitivity settings. Such an arrangement eliminates a common source of instrumentation errors.

INTEGRAL ELECTRONICS ACCELEROMETERS

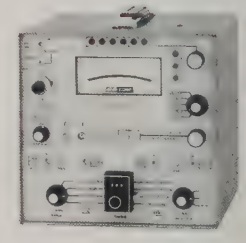
The Model 100PA (100 mV/g) and 1000PA (1000 mV/g) are high sensitivity, low output impedance accelerometers that are particularly well suited for wide dynamic range acceleration measurements and reliable, low level displacement measurements requiring double integration. The 100PA is typically used with the 1610M, 1710M and 2216 Signal Conditioners for measurements down to 1 Hz. The 1000PA provides flat response down to 0.1 Hz with residual noise $\leq$30 micro g when used with the Model 2216 Signal Conditioner.

INDUSTRIAL VIBRATION MONITORING

The Model 8803 Industrial Accelerometer and companion 800 Series Vibration Monitor constitute a unique sensor/instrument system for rotating machinery monitoring and protection. The low output impedance 8803 Accelerometer features simple installation and a rugged two-wire cable. A variety of 800 Series modules are available, including the 841B which takes unique advantage of the TOTAL vibration spectrum by simultaneously measuring low frequency displacement, mid-band velocity, and high frequency acceleration. Individually adjustable alarm functions for each vibration parameter are provided. This technique utilizes information which is essentially ignored by proximity probes and velocity pickups.



The **Model 1602 Transducer Tester** is a fixed frequency, portable test stand which may be used to verify the operation of any vibration transducer. An internal reference accelerometer is utilized to monitor actual test table motion, which is displayed in terms of acceleration, velocity, or displacement on a convenient digital readout. 50 Hz and 100 Hz models are available.



The Model 1710M Vibration Monitor/Analyzer provides a comprehensive capability for measurement and analysis of rotating machinery vibration. When used with the Model 100PA Accelerometer, the 1710M permits wide dynamic range acceleration measurements and excellent low level, low frequency displacement measurements.

A manually tunable 10% bandwidth filter permits identification of specific vibration conditions over the 1 Hz to 10,000 Hz frequency range. Selectable 100 Hz HP filtering of velocity and 1000 Hz HP filtering of acceleration provide a particularly effective means of logging machinery midband and highband vibration characteristics. A unique "wear" feature provides for relative measurement of the severity of impact type vibration indicative of bearing wear, gear wear, rubbing, loose parts, or cavitation.

UNHOLTZ-DICKIE CORPORATION

Barnes Industrial Park North • 6 Brookside Drive • Wallingford, Connecticut • 06492

(203) 265-3929

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Incoming Instrument Inspection and Return Shipping Instructions

1. Unpacking and Inspection

If the shipping carton is damaged, note on acceptance that it is received damaged and subject to claim when inspected. Ask that the carrier's agent be present when the instrument is unpacked and inspected for damage (scratches, dents, broken knobs, etc.). If the instrument is damaged or fails to meet specifications, notify the carrier and the Unholtz-Dickie Corporation immediately. Retain the shipping carton and the padding material for possible return for repair or further inspection by carrier. The purchaser and Unholtz-Dickie Corporation will arrange for the replacement and/or repair of the damaged item.

Refer to our separate warranty page for a statement of our warranty policy.

2. Return Shipment

Return shipment procedure: Please be sure the following instructions are observed if a Model 22 Series instrument is being shipped back to Unholtz-Dickie for repair, replacement, or upon completion of use as a demonstrator or loaner.

2.1 Size of Box and Packing Instructions

2.1.1 Single Channel with 5¼ inch Panel Height

If the single channel was shipped from Unholtz-Dickie as an individual unit, replace the instrument in its original container. If the instrument was shipped as part of a rack mounted combination of channels, the single channel can be returned separately in a container that is no smaller than 22½ inch x 10½ inch x 9½ inch. The front and rear panels must be completely protected by approximately 2 inches of cushioning material. The top, bottom and sides must be surrounded by cushioning and filler materials. A strong, double wall type corrugated box, (350 lb/sq. in. minimum bursting test) has been proven to give adequate service. DO NOT USE A SMALLER OR WEAKER CONTAINER THAN THAT RECOMMENDED ABOVE.

Cover the painted surfaces of the instrument with protective wrapping paper or a plastic bag whenever the packing material might be coarse enough to scratch the painted surfaces.

2.1.2 Six Channel Rack with 5¼ inch Panel Height

CAUTION: Do not rest the rack type instrument in a vertical position with its weight on the rear since the connectors and switches at the rear of the instrument might be damaged.

Replace this instrument in the original container. Replace all packing pads and fillers in the exact position which they originally occupied. If the original container is no longer available, use a container that is no smaller than 27 inch x 20½ inch x 10½ inch.

It is important that protection be provided for the rear connectors and switches during shipment. A sheet of stiff cardboard should be placed under the instrument and then folded up to meet the top of the rear panel. The instrument should be bagged and surrounded on all surfaces by cushioning and filler materials. A strong, double wall type corrugated box (350 lb/sq. in. minimum bursting test) has been proven to give adequate service. DO NOT USE A SMALLER OR WEAKER CONTAINER THAN THAT RECOMMENDED ABOVE.

2.1.3 Single Channel with 8-3/4 inch Panel Height

Follow the instructions given in paragraph 2.1.1, except that extra precautions must be taken to prevent the front panel extension with its meter from being bent during shipment. The extended meter must be braced between packing material so that the load force will be distributed evenly over the entire front panel of the instrument.

2.1.4 Six Channel Rack with 8-3/4 inch Panel Height

Follow the instructions given in paragraph 2.1.2, except that the container size must be no smaller than 26½ inch x 25 inch x 13½ inch.

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UNHOLTZ-DICKIE CORPORATION
BARNES INDUSTRIAL PARK NORTH ■ 6 BROOKSIDE DRIVE, WALLINGFORD, CONNECTICUT 06492 ■ (203)265-3929